A MARK-RECAPTURE EXPERIMENT TO ESTIMATE THE ABUNDANCE OF KUSKOKWIM RIVER SOCKEYE, CHUM, AND COHO SALMON, 2002

By

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OEO/ADA STATEMENT

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ABSTRACT

Chum and coho abundance was estimated in 2002 representing salmon upstream from Kalskag (approximately 309 river km (rkm)) on the Kuskokwim River. Fish wheels and drift gillnets were used to capture fish for tagging. Salmon were tagged with uniquely numbered spaghetti tags and a secondary mark to assess tag loss. At the Kalskag site, 270 sockeye salmon were tagged, and at the Aniak site, 404 were tagged. Five of the fish tagged at Kalskag were recovered at the Aniak Site. There were 18-tagged sockeye salmon observed at the George and Kogrukluk River weirs. The small sockeye salmon run is considered the leading cause in our inability to recover enough tagged sockeye salmon to estimate the population size. At the Kalskag site was 7,822 chum salmon were tagged, and at the Aniak site 12,505 were tagged. Two hundred seventy-nine chum salmon tagged near Kalskag were recaptured at the Aniak site. Crews at escapement projects observed 437 tags of which 23 were observed downstream of the tag sites. The population estimate of chum salmon upstream from Kalskag was 675,659 (95% CI=559,564, 791,755; SE=59,232) using the Darroch estimator. At the Kalskag site, 2,824 coho salmon were tagged, and at the Aniak site 4,148 were tagged. At the Aniak site, 51 coho salmon were recaptured that originated from the Kalskag site. Weir crews observed 607 tagged coho salmon of which 39 were observed downstream of the tag sites. The population estimate of coho salmon upstream from Kalskag was 316,068 (95% CI=193,877, 438,259; SE=62,342) using the Darroch estimator. Travel speeds were progressively faster for tagged chum and coho salmon recovered at weirs furthest upstream from the tag sites. Cumulative percentages of tagged sockeye, chum, and coho salmon recovered at escapement projects indicate fish tagged earliest traveled further upstream than fish tagged later in the season.

KEY WORDS: Kuskokwim River, sockeye salmon, chum salmon, coho salmon, mark-recapture, abundance estimate

INTRODUCTION

Kuskokwim River salmon stocks are difficult to manage for sustainable subsistence and commercial fisheries because of the large size, remoteness, and geographic diversity of the drainage. Although this river is the second largest in Alaska (Moody et al. 1986) and supports one of the largest and most important subsistence fisheries in the state (ADF&G 2001), research and management tools are limited. Inriver subsistence fisheries occur along nearly 1,174 river kilometers (rkm) including approximately 1,011 households from 29 communities. Commercial fishing is allowed in the lower 234 rkm of the river and 840 permits were issued under the state's limited entry program. Salmon spawn in over 28 navigable tributaries (Brown 1983) of the Kuskokwim River beginning in the Kialik River 3 rkm from the mouth to the uppermost headwaters approximately 1,498 rkm away (Burkey et al. 2001).

Ideally, fishery managers have preseason knowledge of salmon run abundance and can accurately assess stock specific run strength. From that knowledge they identify the harvestable surplus above spawning requirements, provide for the priority use by subsistence fishers throughout the drainage, and allow other fishers (sport, commercial, and personal use) to harvest any remaining surplus. The gauntlet nature of this fishery, the necessity to spread harvest opportunity over much of the river, and the potential of differential exploitation especially between upper and lower river stocks increases the challenge. Currently, fishery managers do not forecast run abundance, monitor actual abundance in season, or have sufficient knowledge of run timing differences among stocks to evaluate the need or ability to selectively target or protect stocks. Decisions to open and close fisheries are based on catch per unit effort (CPUE) trends from a gillnet test fishery operated near Bethel, CPUE and catch trends from commercial and subsistence fisheries, and tributary escapement counts. Escapement requirements according to the state's Policy for Statewide Salmon Escapement Goals (5 AAC 39.223) have been identified for eight spawning locations for chinook salmon *Oncorhynchus tshawytscha*, two spawning locations for chum salmon *O. keta*, and one spawning location for coho salmon *O. kisutch* (Buklis 1993). These escapement goals are generally the average escapement observed for each system in the past. Since catch by stock is unknown, traditional spawner-recruit analyses are not possible for individual tributaries.

To meet the challenge of sustainable management of salmon fisheries in the Kuskokwim River, drainage wide abundance and stock specific migratory timing is needed. Abundance estimates are needed pre-season, in season, and as representative of actual spawning abundance (i.e. total abundance minus total harvest equals spawning escapement). Drainage wide abundance, when coupled with a drainage wide escapement goal, allows managers to identify the harvestable surplus. Stock specific migratory timing information is needed to evaluate stock timing differences and to determine if stocks may be differentially harvested through time. Harvest strategies must be evaluated and exploitation rates calculated. A goal of sustainable management would be escapement counts that meet drainage wide requirements with an acceptable distribution within the lower, upper, and middle basins.

This project is designed to estimate the total abundance of chum salmon, sockeye salmon, and coho salmon in the Kuskokwim River upstream from Kalskag using mark-recapture techniques and is a continuation of a project that began in 2001. Fish wheels and drift gillnets were used to

capture adult salmon for marking near Kalskag and Aniak. Marked fish were recovered at the Aniak fishing site and at weirs on upriver tributaries (Figure 1). The use of uniquely numbered spaghetti tags provided determinants of when salmon with tags were released, to supply information on migratory timing in the main stem for salmon stocks spawning in tributaries with weirs. The addition of escapement counts from weirs on major downriver tributaries provided a drainage wide estimate of abundance.

Background: The following narrative reviews the background and history of Kuskokwim River sockeye, chum, and coho salmon mark-recapture experiments, current methods used to evaluate escapement, and the results and funding status of the Kuskokwim River mark-recapture project.

Targeted Species: Chum salmon is the second most important species in the commercial and subsistence harvest. Coho salmon is the most important commercial species (Burkey et al. 2001) and chinook salmon is the most important subsistence species (Coffing et al. 2001). In 2000, Kuskokwim River chum salmon were listed as a stock of concern under the Policy for Management of Sustainable Salmon Fisheries (5 AAC 39.222) because of the chronic inability of managers to maintain expected harvest and escapements levels (Burkey et al. 2000a). No commercial fishing has occurred for chum salmon since 1999 and a subsistence-fishing schedule of 4-days per week was established in 2001. Kuskokwim River coho salmon were identified in the fishery disasters of 1997 and 1998 as declared by the United States Congress. Although sockeye salmon *O. nerka* were not listed as a stock of concern, escapement levels for these species are virtually unknown and remain a concern to managers.

Escapement Monitoring: Weirs were placed on six major tributaries of the Kuskokwim River and a sonar-counting project is operated on a seventh (Figure 1). The weir representative of the Holitna River stock is actually placed on one of its tributaries, the Kogrukluk River, and has annual escapement data dating back to 1976 (Baxter 1976). The Kogrukluk River weir is approximately 220 rkm from the mouth of the Holitna River and 750 rkm from the mouth of the Kuskokwim River. Adult salmon take approximately three to four weeks to pass the weir from the mouth of the Kuskokwim River. The Kogrukluk River drainage is the only system with an escapement goal for chum, coho, and chinook salmon. However, because of the lag time from the commercial and most of the subsistence fisheries, its value to managers for opening and closing fisheries is limited during the early portion of each run. In the mid 1990s, five additional weirs were established to better identify escapement and run strength. These weirs are on the following tributaries: Kwethluk River (Harper and Watry 2001), Tuluksak River (Harris and Harper 2001), George River (Linderman et al. 2003a), Tatlawiksuk River (Linderman et al. 2003b), and Takotna River (Clark and Molyneaux 2003b). A sonar project on the Aniak River is used to index chum salmon escapement (Burkey et al. 2001), which is the dominant salmon species during its migration period. An escapement goal has been set for chum salmon in the Aniak River.

Abundance Estimates: For many years researchers and managers recognized the importance of migratory timing information, travel speed, and abundance estimates for adult salmon returning to spawn. Numerous tagging projects were conducted on large river systems such as the Kuskokwim and Yukon Rivers where gauging run strength is complex. Early mainstem tagging projects on the Kuskokwim and Yukon Rivers were not designed to estimate abundance and had limited success otherwise. In the 1960s, tagging studies were conducted on the Kuskokwim

River (ADF&G 1961a, 1962a, 1966) and the Yukon River (ADF&G 1961b, 1962b, 1964, 1969). Distance traveled by tagged fish and the number of days between release and recapture were calculated from these data, but stock-specific information was lacking. The primary reasons for this lack were the inability to tag enough fish and the absence of tributary projects to recover tags. No stock-specific mark and recovery data were available. The greatest number of tags deployed during this period on the Kuskokwim River was 362 chinook salmon (ADF&G 1966).

Recently, researchers again tried to characterize migration-timing differences among salmon stocks in the Kuskokwim River. In 1995, the Bering Sea Fishermen's Association funded a radio telemetry study for chum salmon (Parker and Howard 1995). The primary goal of this project was to identify temporal differences in the migration of chum salmon stocks as they pass through the lower river commercial fishing district. The project fell short in reaching this goal because too few chum salmon were tagged and receiver stations failed.

Progress was made during one of the first mark-recapture experiments in Alaska designed to estimate abundance and describe migratory timing in a large river under remote conditions. From 1982 to 1985 on the Susitna River, Barrett et al. (1984a and 1984b) demonstrated that large numbers of adult salmon could be tagged and recovered using fish wheels, supplemented by tributary monitoring for mark to unmarked data. The Susitna River is the fifth largest river in Alaska and supports large runs of chinook, chum, sockeye, coho, and pink salmon.

Improvements in tagging techniques, fish handling and capture gear, coupled with advances in estimation modeling (Schwarz and Seber 1999) and the testing of model assumptions, permit researchers to now use mark-recapture experiments throughout Alaska to estimate the population size of adult salmon migrating up large rivers. Population estimates were calculated for chinook salmon in the lower Yukon River (Spencer et al. 2002) and at the Yukon River border with Canada (Johnson et al. 2002), Keta River (Brownlee et al. 1999), Kenai River (Hammarstrom and Hasbrouck 1998, 1999), Taku River (McPherson et al. 1998), Stikine River (Pahlke and Etherton 2000), Copper River (Evanson and Wuttig 2000), and recently the Holitna River (Wuttig and Evenson 2002). Chum salmon abundance was estimated for the upper Tanana River (Cappiello and Bruden 1997; Cappiello and Bromaghin 1997; Herbert and Bruden 1998; Cleary and Bruden 2000; Cleary and Hamazaki 2002), the upper Yukon River (Underwood 1998), and the Yukon River at the border with Canada (JTC 2002). These Yukon River projects provide inseason estimates of chum salmon and use fish wheel release and recovery methods. Coho salmon abundance has been estimated using mark-recapture techniques on the Kenai River (Carlon 2000), Chilkat River (Ericksen 1999), Steep Creek (Jones and McPherson 1997), Unuk River (Jones et al. 2001), and Holitna River (Wuttig and Evenson 2002). This list is not meant to be exhaustive but reflective of the successful application of the technique in large rivers in Alaska.

Kuskokwim River Mark-Recapture Project: Following declaration of the 1997 and 1998 fisheries as disasters in Bristol Bay, and the Kuskokwim and Yukon Rivers, the United States Congress appropriated $7 million to develop a disaster research and prevention plan. The resulting Western Alaska Salmon Fisheries Disaster Mitigation Research Plan (WASFDP) (ADF&G 1999) recognized the health of western Alaska salmon runs as critically important to residents of this area. The list of critically important species included Kuskokwim River coho salmon. The WASFDP grant awarded $495 thousand to the Alaska Department of Fish and

Game (ADF&G) to estimate abundance and migratory timing characteristics of coho salmon in the Kuskokwim River using mark-recapture techniques.

WASFDP was revised in 2001 to replace the Kuskokwim River sonar project (Eggers 2001) with additional studies to estimate salmon abundance using mark-recapture techniques on the Kuskokwim. Revisions to WASFDP redirected sonar funds to expand the scope of the mark recapture project to include chinook, chum, and sockeye salmon because of their importance to subsistence and commercial fishers, their recent declines in abundance, and limited abundance information available to fisheries managers. ADF&G Division of Sport Fish was funded to estimate the abundance of chinook salmon in the Kuskokwim River using radio telemetry and mark recapture techniques. In 2002, the State of Alaska general fund project, *Kuskokwim River Sonar*, was redirected to support the coho, sockeye, and chum salmon project. In addition, the USFWS Office of Subsistence management (OSM) funded a fisheries biologist with the Kuskokwim Native Association (KNA) to contribute to the sockeye, chum, and coho salmon project.

Funding from the WASFD grant for the chum, sockeye and coho salmon mark recapture project ended June 30, 2003. Furthermore, this project was designed to exhaust those funds after the 2002 field season and 2003 data analysis and reporting.

Throughout the first year of operation, ADF&G worked with KNA to design and construct four fish wheels, to select fish wheel sites, to build a field campsite near Aniak, and to organize logistics for the recovery of tags. In this feasibility year, we tested the success of various fish wheel sites, fish wheel fishing configurations, and gillnet drift locations. We investigated tag recovery methods at weir sites and conducted a tag lottery. In this first year, 3,027 coho salmon were tagged near Kalskag (1,291) and Aniak (1,736) (Figure 2). Only 13 coho salmon tagged at Kalskag were recovered upriver at our Aniak site. Personnel at the George, Kogrukluk, Tatlawiksuk, and Takotna weirs recovered 214 tags. Recovery rates were significantly different between weir recapture sites. We did not think this difference was caused by a delayed mortality, because the difference was not related to the distance to the weir recovery site. Instead, the recovery rate was related to the distance from the release site to the confluence of the river drainage in which the weir was placed. Tag recovery rates were higher for middle basin tributaries (Kogrukluk and George) than upper basin tributaries (Tatlawiksuk and Takotna). For example coho salmon had to travel as far and long to pass the Kogrukluk weir in the Holitna River drainage (a middle basin river) as the two upper basin weirs, but the confluence of the Holitna River is much closer to the release site (Figure 1). We hypothesized offshore stratification by stock occurred at the tag sites and coho salmon were not tagged relative to abundance. Actions were taken to correct this discrepancy in 2002 to include drift gillnetting for coho salmon offshore of the fish wheels.

METHODS

Project Objectives

1. Estimate abundance of sockeye, chum, and coho salmon in the Kuskokwim River upstream of Kalskag, rkm 310 with a relative precision (coefficient of variation) of +/- 20% or less.
2. Estimate run timing of stocks passing the Kalskag and Aniak sites that are monitored at tributary escapement projects.
3. Estimate mean travel speed of chum, sockeye, and coho salmon tagged at the Kalskag and Aniak sites and recovered at the upstream escapement projects.

This study was designed to allow two opportunities to estimate the population using mark recapture methods. The first mark-recapture event is between Kalskag (309 rkm) and Aniak (341 rkm) (Figure 1). The second estimation is between the Kalskag/Aniak tag sites and upstream escapement projects. The approximate distance from the Kalskag and Aniak tagging sites respectively to upstream escapement projects are: Aniak River Sonar (72 and 40 rkm), George River weir (166 and 134 rkm), Kogrukluk River weir (423 and 391 rkm), Tatlawiksuk River weir (283 and 251 rkm), and Takotna Rivers weir (564 and 532 rkm). Fish wheels and drift gillnets were used for capturing salmon from June 16 to September 10 at the Kalskag site and from June 14 to September 11 at the Aniak site. Tag recovery at upstream escapement projects occurred from June 26 to July 31 at Aniak River sonar, from June 21 to September 20 at George River weir, from June 26 to September 24 at Kogrukluk River weir, from June 17 to September 22 at Tatlawiksuk River weir and from June 23 to September 20 at Takotna River weir.

The Kalskag and the Aniak tagging sites were selected because: (1) the sites were located approximately 300 rkm upstream from the mouth of the Kuskokwim River, where fish should be physiologically adjusted to living in freshwater and more tolerant of capture and tagging stresses; (2) harvest of tagged fish should be reduced, because sites were located above Bethel, where approximately one-third of the fish are harvested; (3) the sites are still below many salmon spawning streams; (4) the water current at the sites was adequate for fish wheel operation used to capture the salmon; and (5) the distance between the two sites was assumed far enough for the tagged salmon to mix with untagged salmon.

Capture Methods

Fish Wheels

Four fish wheels were used to capture salmon for tagging. One pair was anchored upstream from Kalskag (309 rkm) and a second pair just downstream from Aniak (336 rkm). Each fish wheel pair was designated as right or left bank. Right bank wheels were defined as wheels anchored on the right side of the river when facing downstream. Each fish wheel consisted of three aluminum baskets measuring 2.4 × 3.0 m (length, width), a live box measuring 2.4 × 1.2 × 0.06 m (length, width, depth) made of plywood and perforated with holes attached to the offshore side of each

fish wheel, and a weir (length ~ 5 m) positioned perpendicular to the bank along the onshore side of each fish wheel.

Fish wheels were operated continuously, except for periods of maintenance, adjustment, and relocation. Two crews were assigned to each tag site. A crew consisted of two people who worked one 7.5-hour shift each day. During each shift, the crew would sample fish from each fish wheel approximately every 2 hours. Initially, the two shifts were from 0600 to 1400 hours and from 1800 to 0020 hours, but as the season progressed and daylight hours shortened, the schedule progressively adjusted until at the end of the season the two shifts were from 0800 to 1600 hours and 1500 to 2400 hours.

Drift Gillnets

In addition to fish wheels, drift gillnet were also used to capture salmon. At the Kalskag site, gillnetting was conducted from June 20 to September 10. At the Aniak site, gillnetting was conducted from June 20 to June 29 and from July 25 to September 11. One mesh size was used, 4-in (10.16 cm). Gillnets measured 45 meshes deep and were either 15 fathoms (27.43 m) or 25 fathoms (45.72 m) in length. The net length the crew fished on a given day was based on catch rates; for example, the crew used the 15-fathom gillnet when catch rates were high. The crew deployed gillnets from an 18-ft (5.5 m) skiff, and immediately began retrieving the net at the first sign a fish was entangled. Any species of fish caught other than chum, sockeye, or coho salmon were immediately released. Target species, however, were freed from the net and lifted into the skiff where they were placed into a tub of fresh river water, tagged, and released. When too many target species were caught, excess fish were immediately released without tagging.

Tagging

Tagging consisted of one primary and one secondary mark. The primary mark was a 36-cm spaghetti tag reinforced with jeweler wire. Each tag had a unique identification number and the phone number of the ADF&G Anchorage office. Initially four tag colors were scheduled for use on this project. However, because we ran out of the initial tag order, USFWS, and the Yukon River chinook salmon radio telemetry projects supplied additional tags that resulted in seven tag colors used to distinguish the tagging site. Fluorescent pink, fluorescent orange, and white were used for fish caught by fish wheels in Kalskag, green, fluorescent green, white, and yellow tags for fish caught in Aniak. The secondary mark was a hole-punch through the adipose fin. Secondary marks were used to access tag loss.

Salmon selected for tagging were placed in a plywood cradle filled with river water. The amount of data collected on each tagged fish depended on catch rates. When catches rates were manageable, the following data were recorded for each sockeye, chum, and coho salmon: mid-eye–to–fork (MEF) length measured to the nearest 5 mm, sex (determined from external characteristics), injuries (snout damage, split fins, net marks, lamprey wounds, and seal bites), and skin color to indicate spawning condition (bright silver, silver-pink, dark-pink, dark red).

When catches were high, crews recorded lengths on every n^{th} of the target species. The purpose of this was to increase the number of fish tagged within the two-hour sampling block. Once a crew sampled for two hours, the fish remaining in the live box were inspected for tags and secondary marks, counted then released. Healthy sockeye, chum, and coho salmon were tagged with spaghetti tags. Each tag was sewn through the back just below the dorsal fin and about four rays up from the posterior side of the dorsal fin then secured by crimping both ends of the spaghetti tag together in a brass sleeve. A paper punch was used to cut a hole in the adipose fin. Unhealthy salmon were released without a tag. Bycatch fish were identified, counted, and then released.

Tag Recovery

At the Aniak site, fish wheels and gillnets were used to recover Kalskag tagged fish. Tagging crews recorded recapture date and tag number from each recaptured fish.

Six weir projects were used as tag recovery sites (Figure 1), two of the weirs were located downstream of the tagging site, and four were located upstream. The upstream weirs were located on the George and Kogrukluk Rivers (middle basin), and Tatlawiksuk and Takotna Rivers (upper basin). Weir crews captured tagged fish as the fish passed through the weir, and recorded date and tag number; these fish are described as "recovered" tags. When crews could not capture tagged fish because of high water or capture difficulties, they recorded tag color and date observed. Weir crews inspected untagged fish for the presence of secondary marks to assess the incidence of tag loss, these fish are described as "inspected". For further details of the weir operations, see Linderman et al. (2003a, 2003b) and Clark et al. (2003a, 2003b).

Tagged fish were caught by subsistence, commercial and sport fishers. Fishers were encouraged to return tags through a tag lottery. The lottery was advertised with posters, radio announcements, and public meetings. Tag recovery data were received through a toll free phone number to the Anchorage ADF&G regional office and through reporting via phone or walk ins to the ADF&G area office in Bethel, Kuskokwim River tribal offices, and the USFWS. Tag recovery data were recorded on paper forms then entered into an Access database postseason.

Data Analysis

Travel Speed

Fish travel speed (rkm/day) from fish tagged from fish wheels and gillnets at the Kalskag and Aniak sites to weirs was modeled as a gamma random variable using a generalized linear model. Explanatory variables considered for inclusion in the model included Julian date, total travel distance, sex, and fish length. The parameters of the model were estimated using the Genmod procedure of SAS version 8.02 (SAS Institute Inc. 1999). Analysis began by fitting a model including all the explanatory variables. Terms were eliminated in a stepwise fashion. This procedure continued until all remaining terms were statistically significant.

Assumptions

The following assumptions for this mark-recapture study were tested:

1) handling and holding in the fish wheel live box of salmon will not affect weir recapture success,
2) all marked fish will mix completely with unmarked fish between sampling events.

To test the first assumption of no holding effect on weir recapture success of tagged fish, holding density was calculated as number of fish in the live box divided by the time held in the live box. Probability of passing a weir was modeled as a binomial random variable. Explanatory variables included in the model were holding density, sex, and length.

To examine the second assumption, equality of tagged-untagged ratio was examined among various tag recovery sites (weirs) and among time strata of fish wheel and gillnet data using chi-square analysis.

When the above two assumptions were met, the Chapman estimator (Seber 1982) was used to estimate abundance. When tagged-untagged ratios differed temporally, a Darroch Estimator (Seber 1982) was used with fish wheel and gillnet data stratified through time. When tagged-untagged ratios differed among weirs, these data were not used in abundance estimation.

Significant differences among length distributions of tagged and untagged salmon as measured at weir sites were tested using a two-sample Kolmogorov-Smirnov test. Differences between tagged and untagged salmon would indicate a size selective bias by fish wheels and or gillnets. The population estimate based only on fish wheel and gillnet data would then represent a subset of the true population, that being the portion vulnerable to fish wheel and or gill net capture.

Abundance Estimate

ML Darroch Estimator of Abundance

"Darroch's estimates of abundance, SE, and 95% CI were obtained by using ML Darroch estimator of the SPAS (Arnason et al. 1996).

$$\hat{N} = \hat{U} + \sum_{i=1}^{s} a_i \quad \hat{U} = u' M^{-1} a ,$$

$$u = \begin{bmatrix} u_1 \\ \vdots \\ u_j \\ \vdots \\ u_t \end{bmatrix} \qquad a = \begin{bmatrix} a_1 \\ \vdots \\ a_i \\ \vdots \\ a_s \end{bmatrix} \qquad M = \begin{bmatrix} m_{11} & \cdots & m_{1j} & \cdots & m_{1t} \\ \vdots & \ddots & & \iddots & \vdots \\ m_{i1} & & m_{ij} & & m_{it} \\ \vdots & \iddots & & \ddots & \vdots \\ m_{s1} & \cdots & m_{sj} & \cdots & m_{st} \end{bmatrix}$$

where:
$\hat{U}$ = the estimated abundance of unmarked fish in the population at the Aniak site.
u_j = the number of unmarked fish in the j-th stratum at the Aniak site
a_i = the number of marked fish released in the i-th stratum passing Kalskag
m_{ij} = the number of marked fish released in i-th stratum passing Kalskag and recaptured in the j-th stratum at the Aniak site

The Standard Error for Darroch's abundance estimates was obtained using standard likelihood method (Arnason et al. 1996).

Temporal Stratification
Initially stratum boundaries were set based on the graphical display of the daily proportion of fish tagged at the Kalskag site (compared to the season total) and the daily proportion of tagged fish recovered (compared to the season total) at the Aniak site. The goal within each stratum was to group similar proportions of fish recovered at the Aniak site through time. A chi-square test was used to determine differences among strata.

RESULTS

Sockeye Salmon

Tag Deployment

Six hundred seventy four sockeye salmon were tagged between June 15 and September 7 using a combination of fish wheels and drift gillnets; 270 fish were tagged at Kalskag and 404 at the Aniak site (Table 1; Appendix A). More sockeye salmon were caught in the left bank fish wheels (55%: in Kalskag, and 71% in Aniak) than in right bank fish wheels or in gillnets. Fifty percent of the sockeye salmon captured were caught by July 9 at Kalskag and July 7 at the Aniak site (Appendix A). Fifty percent of the run peak catch per unit effort (CPUE) occurred from June 20 to July 16 in fish wheels and gillnets (Figure 3, 4, 5).

Crews tagged 93.9% of the sockeye salmon captured in fish wheels and gillnets at the Kalskag

site (Figure 6). The sockeye salmon released untagged were either unhealthy or escaped during handling. At the Aniak site, crews were unable to tag all healthy sockeye salmon caught in fish wheels because of high catch rates of chum salmon (Figure 7). From July 2 to July 15, 53.2% of the sockeye salmon captured in fish wheels were tagged.

Tag Recovery

Tagging Sites

Eight tagged sockeye salmon were recaptured at Kalskag, seven of these fish originated from Kalskag and one from the Aniak site (Table 1; Appendix A1). Eleven tagged sockeye salmon were recaptured at the Aniak site, five originated from Kalskag and six from the Aniak site (Table 1; Appendix A2). Of the sockeye salmon tagged in Kalskag then recaptured at the Aniak site, 60% were captured and recaptured on the same bank, 40% were capture and recaptured on the opposite bank (Figure 8). None of the sockeye salmon tagged from gillnets at the Kalskag site were recaptured at the Aniak site.

Weir Sites

Twenty-six tagged sockeye salmon were observed at escapement projects (Table 2), of which five were recaptured or observed downstream of the tagging sites, and 21 were recaptured or observed at upstream sites. Approximately 54% of the observed tags came from the Kogrukluk River weir.

Voluntary Tag Recoveries

Twenty-three tags were returned from subsistence, commercial and sports fisheries (Table 3; Appendix B), of which six were captured downstream, two near the tagging sites, and 12 above the tagging sites. Of the tags recovered upstream from the tagging sites, 42% were recovered near the Aniak River, and 42% from the Holitna and Stony River drainages (Appendix B).

Travel Speed and Travel Days

The mean travel speed and travel days for sockeye salmon tagged at Kalskag and recaptured at the Aniak site was 22 rkm/day (n=5, SE=10.7) and 2 days (Table 4). Tag recoveries from upstream escapement projects showed an increase in travel speed with an increase distance from the tag site (Table 4; Figure 9). The mean travel speed of fish recovered at the Aniak River sonar site was 16 rkm/day (n=3, SE =5.34), at the George River weir was 21 rkm/day (n=4, SE=2.42), and at the Kogrukluk River weir was 28 rkm/day (n=12, SE=5.83).

Run Timing

Cumulative percentages of tagged sockeye salmon recovered at escapement projects indicate sockeye salmon tagged earliest traveled further upstream than fish tagged later in the season (Figure 10). Kolmogorov-Smirnov test (K-S test) indicated a significant difference (alpha=0.05;

P<0.01) between the cumulative percentage curves. Fifty percent of the sockeye salmon captured at the tag sites were caught by July 20. Fifty percent of the sockeye salmon recaptured at the Kogrukluk River and George River, were tagged by July 19, and July 23 respectively.

Abundance Estimate Diagnostics

Effects of Holding Time and Density

There was no significant difference in recapture probability for sockeye salmon tagged at the Kalskag site and recaptured at the Aniak site based on holding time or on fish density in a live box (Chi-square=1.49, df=1, P =0.2215). When the probability of recapture was tested between Kalskag-Aniak pooled data and the weirs, no significant difference was detected (Chi-square=0.11, df=1, P=0.7435).

Tag Recovery Ratios

The recovery ratios (tagged: total) of sockeye salmon at the George River weir and Kogrukluk River weir were significantly different (Chi-square = 4,077, df = 1, P < 0.001). Because of the significant difference between weir recovery sites we did not use these data to estimate sockeye salmon abundance.

Tag Loss

Few sockeye salmon were inspected for secondary marks at escapement projects above the tag sites. No tag loss was observed on sockeye salmon inspected at the Aniak sonar site (n=5) or the Kogrukluk River weir (n= 39) (Table 5).

Abundance Estimate

Significantly different tag ratios among weirs were thought to represent violation of an assumption underlying our abundance estimator and therefore these data were not used to estimate the sockeye salmon population. Furthermore, an abundance estimate using recovery data from the Aniak tag site was also not made. Too few tags (n=5) were recovered. Chapman (1951, in Seber 1982) warns that estimates based on fewer than 10 recoveries may fail to give even the order of magnitude of the population correctly.

Chum Salmon

Tag Deployment

A total of 20,327 chum salmon was tagged between June 14 and September 11 using a combination of fish wheels and drift gillnets; 7,822 chum salmon were tagged at Kalskag and 12,505 at the Aniak site (Table 6; Appendix C). The right bank fish wheel at the Kalskag site

caught a higher number (63.6%) of chum salmon than the left bank fish wheel (Table 6; Appendix C1). In contrast, the left bank fish wheel at the Aniak site caught a higher number of fish (53.3%) than the right bank wheel (Appendix C2).

Peak chum salmon fish wheel CPUE's at Kalskag occurred from July 5 to July 20, and at the Aniak site from July 8 to July 14 (Figure 11, 12). At the Aniak tag site, no drift gillnetting occurred from June 29 through July 30 because of high fish wheel CPUEs (Figure 13; Appendix C2). In July, fish wheel catches were lower in Kalskag and drift gillnet fishing was not disrupted. However, gillnet fishing effort was reduced during this period (Figure 10; Appendix C1). Fifty percent of the chum salmon captured were caught by July 14 at Kalskag and July 11 at the Aniak site (Appendix C).

Crews tagged 91.8% of the chum salmon capture in fish wheels and gillnets at the Kalskag site (Figure 14). The chum salmon released untagged were either unhealthy or escaped during handling. At the Aniak site, crews were unable to tag all healthy chum salmon caught in fish wheels because of high CPUE's (Figure 11, 12). From July 2 to July 29, only 59% of the chum salmon captured in fish wheels were tagged (Figure 15).

Tag Recovery

Tagging Sites

A total of 181 tagged chum salmon was recaptured at Kalskag; of these fish, 163 were tagged at the Kalskag site and 18 from the Aniak site (Table 6; Appendix C1). Four hundred nine chum salmon were recaptured at the Aniak site of which 279 originated from Kalskag and 130 from Aniak (Appendix C2). Of the chum salmon tagged in Kalskag then recaptured at the Aniak site, 59.9% were captured and recaptured on the same bank, 39.8% were captured and recaptured on the opposite bank, and <1% were tagged from a gillnet and recaptured in a fish wheel (Figure 16).

Weir Sites

A total of 437 tagged chum salmon was observed at escapement projects (Table 7), of which 23 were recaptured/observed downstream of the tagging sites and 414 upstream of the tagging sites. Seventy-three tags were recovered at the Aniak River sonar site. Seventy-five percent of these fish were tagged from the left bank fish wheel at the Aniak site.

Voluntary Tag Recoveries

Six hundred seventy eight tags were returned from subsistence, commercial and sports fisheries (Table 8; Appendix D), of which 249 were captured downstream, 317 captured upstream, and 90 captured near the tagging sites. Approximately 45% of the tags recovered above the tagging sites were captured near the Aniak River.

Travel Speed and Travel Days

Mean travel speed and travel days for chum salmon tagged at Kalskag and recaptured at the Aniak site was 19 rkm/day (n=279, SE=0.19) and 2 days (Table 9). Twenty-four fish were recaptured at the Aniak site on the same day they were tagged at Kalskag. One chum salmon was recaptured 31 days after being tagged at Kalskag.

Travel speed of tagged chum salmon differed significantly between weirs (Chi-square=54.42, df=4, $P < 0.0001$) even after accounting for the variation caused by tag date (Chi-square=9.02, df=1, $P < 0.0027$) and travel distance to weirs (Chi-square=6.5, df=1, $P < 0.0108$). Speed increased as distance from the tag site increased (Table 9; Figure 17). Mean travel speed of fish recovered at the Aniak River was 18 rkm/day (n=72, SE=1.18), at the George River weir 29 rkm/day (n=106, SE=0.91), Kogrukluk River weir 33 rkm/day (n=66, SE=0.65), Tatlawiksuk River weir 28 rkm/day (n=119, SE=2.77), and the Takotna River weir 36 rkm/day (n=6, SE=1.79).

Run Timing

Cumulative percentages of tagged chum salmon recovered at escapement projects indicate chum salmon tagged earliest traveled further upstream than fish tagged later in the season (Figure 18; Linderman et al. 2003a, 2003b; Clark and Molyneaux 2003a, 2003b). Kolmogorov-Smirnov test indicated a significant difference (alpha=0.05; $P<0.01$) between the cumulative percentage curves. The Kalskag and Aniak sites caught 50% of the total chum salmon catch by July 11. Fifty percent of the chum salmon recaptured at the Takotna River weir were tagged by June 18 (n =6), at the Tatlawiksuk River weir by June 5 (n=103), at the George River weir by June 9 (n=97), and at the Aniak River sonar site by June 12 (n=69). The Kogrukluk River weir was the exception to the run timing patterns observed at the escapement projects. Even though the Kogrukluk River weir is one of the furthest upstream escapement projects, run timing was latest (fifty percent of the recaptures were tagged by June 25 (n=66)).

Abundance Estimate Diagnostics

Length

Mean chum salmon length at the Kalskag tag site was 561.1 mm (n=6,524, SE=0.484), at the Aniak tag site was 567.8 mm (n = 6,349, SE=0.497), at the George River was 570.6 mm (n=1,059, SE=1.265), at the Kogrukluk River was 565.9 mm (n=580, SE=2.658), at the Tatlawiksuk River was 556.3 mm (n =1,418, SE=1.737), and at the Takotna River was 578.5 mm (n =880, SE=1.186) (Table 10).

No significant difference was detected in the tagged and untagged population at the Aniak tag site (two-sample Kolmogorov-Smirnov test detected P =0.5312), nor at the escapement projects: Aniak River sonar (P=0.6743), George River weir (P=0.3481), Kogrukluk River weir (P=0.4331), or Tatlawiksuk River weir (P=0.0096).

Effects of Holding Time and Density

There was no significant difference in recapture probability for chum salmon tagged at the Kalskag site and recaptured at the Aniak site based on holding time or on fish density in a live box (Chi-square=0.43, df=1, P =0.5101). When the probability of recapture was tested between Kalskag-Aniak pooled data and the weirs, no significant difference was detected (Chi-square=0.2, df=1, P=0.6564).

Tag Recovery Ratios

Overall, the recovery ratio (tagged: total) of chum salmon at escapement projects ranged from <0.001 to 0.02 (Table 7). Ratios at escapement projects above the tagging sites were significantly different (Chi-square=594.035, df=4, P<0.0001). The Kogrukluk and Takotna River weirs had the lowest ratio (0.002). The recovery ratio at the Aniak tag site was 0.0145. Because of the significant difference among escapement recovery sites we did not use these data to estimate chum salmon abundance.

Tag Loss

A total of 13,538 chum salmon was inspected for secondary marks at escapement projects above the tag sites. Only one chum salmon was inspected at the Tatlawiksuk River weir with a secondary mark but no tag (Table 5).

Abundance Estimate

An estimate of chum salmon abundance upstream from Kalskag was calculated using the Kalskag and Aniak fish wheel-gillnet data set. Tags recovered in the lower basin were subtracted from the tags deployed at the Kalskag site. The effect of tag loss was considered insignificant, and not incorporated into the analysis.

Mark and recapture data were stratified by time using the daily proportion of tags recovered at the Aniak site and the daily proportion of tags deployed at the Kalskag site (Table 11, Figure 19). The first stratum (June 14 to July 10) began on the first day of tagging and ended when the daily proportion of the season's total tags deployed were high at the Kalskag site and a low daily proportion of recaptured fish were recovered at the Aniak site. The second stratum (July 11 to August 1) ended when the proportion of tags deployed at the Kalskag site and the proportion of tags recovered at the Aniak site dropped. The third stratum (August 2 to September 12) is characterized by low daily proportions at Kalskag and high daily proportions of tags recovered at the Aniak site. The high proportions of tags recovered at the Aniak site in the third stratum may reflect milling activity of the tagged population.

Proportions of chum salmon recaptured at the Aniak site were significantly different between strata (Chi-square=84.64, df=2, P<0.00). The probability of recapture within the third stratum

(P=0.0745) was almost four times higher than the first (P=0.0201) and almost two times higher than the second (P=0.0425) stratum.

An estimate of chum salmon abundance upstream of Kalskag using the Darroch estimator was 675,659 fish (95% CI=559,564, 791,755; SE=59,232; Table 12).

Coho Salmon

Tag Deployment

Between June 28 and September 12, 6,972 coho salmon were tagged using a combination of fish wheels and drift gillnets; 2,824 fish were tagged at Kalskag and 4,148 at the Aniak site (Table 13; Appendix E). At the Kalskag and Aniak sites, fifty percent of the total coho salmon caught were captured by August 17 and 21 respectively. The right bank fish wheels caught the highest percentage of coho salmon at the Kalskag (56%) and Aniak (48%) sites. The percentage of coho salmon caught in the left bank fish wheel at Kalskag (21%) was similar to the gillnet catch (23%). Also the percentage of coho salmon caught in the Aniak left bank wheel (28%) was close to the gillnet catch (23%).

Peak coho salmon fish wheel CPUE's at Kalskag occurred from August 19 to August 25 and from August 6 to August 18 at the Aniak site (Figure 20, 21, 22; Appendix E). Of the total coho salmon catch, crews tagged 94.4% of the catch at the Kalskag site and 96.3% at the Aniak site (Figure 23, 24). The coho salmon released untagged were either unhealthy or escaped during handling. At the Kalskag site, crews were unable to tag all healthy coho salmon caught in drift gillnets when CPUE's were high.

Tag Recovery

Tagging Sites

Fifty tagged coho salmon were recaptured at the Kalskag site of which 39 originated from Kalskag and 11 from the Aniak site (Table 13; Appendix E1). At the Aniak site, 51 tags were recovered from fish tagged at the Kalskag site (Appendix E2). Of the coho salmon tagged in Kalskag then recaptured at the Aniak site, 25.5% were captured and recaptured on the same bank, 39.2% were captured and recaptured on the opposite bank, and 1.9% captured and recaptured in gillnets, and 33.3% were captured and recaptured using a combination of gillnets and fish wheels (Figure 25).

Weir Sites

A total of 607 tagged coho salmon were observed at escapement projects (Table 14), of which 39 were recaptured/observed downstream of the tagging sites and 568 above the tagging sites.

Voluntary Tag Recoveries
A total of 244 tags were returned from subsistence, commercial and sports fisheries (Table 15; Appendix F), of which 47 were captured downstream, 170 captured upstream, and 21 were captured near the tagging sites. Approximately 53% of the tags recovered upstream from the tagging sites were captured near the Aniak River.

Travel Speed and Travel Days

Mean travel speed and days traveled of coho salmon tagged at Kalskag and recaptured at the Aniak site was 14 rkm/day (n=51, SE=10.682) and 3.3 days respectively (Table 16). Four fish were recaptured at the Aniak site, on the same day they were tagged at Kalskag. Two fish were recaptured at the Aniak site 19 days after being tagged in Kalskag.

Mean travel speed of fish recovered at the George River weir was 13 rkm/day (n=62, SE=0.756), Kogrukluk River weir 26 rkm/day (n=210, SE=0.416), Tatlawiksuk River weir 23 rkm/day (n=122, SE=0.671), and the Takotna River weir 29 rkm/day (n=50, SE=0.836).

Travel speed of tagged coho salmon differed significantly among weirs (Chi-square=151.94, df=3, $P < 0.0001$) even after accounting for the variation caused by changes in tag date (Chi-square=243.58, df=1, $P < 0.0001$) and travel to distance weirs (Chi-square=20.2, df=1, $P < 0.0001$). Speed increased when distance from the tag site increased (Table 16; Figure 26).

Run Timing

Cumulative percentages of tagged coho salmon recovered at escapement projects indicate coho salmon tagged earliest traveled further upstream than fish tagged later in the season (Figure 27; Linderman et al. 2003a, 2003b; Clark and Molyneaux 2003a, 2003b). Kolmogorov-Smirnov test indicated a significant difference (alpha=0.05; $P<0.01$) between the cumulative percentage curves. The Kalskag and Aniak sites caught 50% of the total coho salmon catch by August 18. Fifty percent of the coho salmon recaptured at the Takotna River weir were tagged by August 12 (n= 50), the Kogrukluk River weir by August 20 (n=208), the Tatlawiksuk River weir by August 19 (n=103), the George River weir by August 22 (n=60).

Abundance Estimate Diagnostics

Length
Mean coho salmon lengths at the Kalskag site was 556.1 mm (n = 2,803, SE = 0.960), the Aniak site was 558.2 mm (n = 4,096, SE = 1.753), the George River weir was 545.4 mm (n = 83, SE = 5.083), the Kogrukluk River weir was 560.7 mm (n = 474, SE = 1.487), the Tatlawiksuk River weir was 561.3 mm (n = 639, SE = 1.670), and the Takotna River weir was 561.0 mm (n = 391, SE = 2.355) (Table 17).

No significant difference was detected in the tagged and untagged population at the Aniak site (two-sample Kolmogorov-Smirnov test detected P=0.202), nor at the George River (P=0.0222)

or Tatlawiksuk River (P=0.3381). Significant differences were detected at the Kogrukluk River (P < 0.0001) and the Takotna River (P=0.0002).

Effects of Holding Time and Density

There was no significant difference in recapture probability for coho salmon tagged at the Kalskag site and recaptured at the Aniak site based on holding time or on fish density in a live box (Chi-square=0.43, df=1, P =0.5101). When the probability of recapture was tested between Kalskag-Aniak pooled data and the weirs, no significant difference was detected (Chi-square=0.2, df=1, P=0.6564).

Tag Recovery Ratios

Overall, the recovery ratio (tagged: total) of coho salmon at the weirs ranged from <0.001 to 0.017 (Table 14). Ratios at escapement projects above the tagging sites were significantly different (Chi-square=766.95, df=3, P<0.0001). The tag ratio at the Aniak site was 0.0116. Because of the significant difference among escapement recovery sites we did not use these data to estimate coho salmon abundance.

Tag Loss

A total of 5,214 coho salmon was inspected for secondary marks at escapement projects above the tag sites (Table 5). No tag loss was observed on coho salmon inspected at the George River weir (n=359), Kogrukluk River weir (n=718), Tatlawiksuk River weir (n=1,799) or Takotna River weir (2,338) (Table 5).

Abundance Estimate

Estimates of abundance upstream from Kalskag were calculated using the Kalskag and Aniak fish wheel and gillnet data set. Tags recovered in the lower basin were subtracted from the tags deployed from Kalskag. The effect of tag loss was considered insignificant, so it was not incorporated into the analysis.

Mark and recapture data were stratified using daily proportion of tags recovered at the Aniak site and daily proportion of tags deployed at the Kalskag site (Table 18, Figure 28). The first stratum (June28 to August 7) began the first day a coho salmon was tagged at the Kalskag site and ended the day following a high daily proportion of recaptured fish. The second stratum (August 8 to August 23) ended the day following a high proportion off recaptured fish. The third stratum (August 24 to September 12) contains the highest proportion of tags recovered at the Aniak site, and marks the end of the project.

Proportions of coho salmon recaptured at the Aniak site were significantly different among strata (Chi-square=24.38, df=2, P= 0.00). The probability of recapture within the third stratum (P=0.0285) was over two times higher than the first (P=0.012) or second (P=0.011) strata.

An estimate of the total coho salmon abundance upstream of Kalskag using the Darroch estimator was 316,068 fish (95% CI=193,877, 438,259; SE=62,342; Table 19).

DISCUSSION

The design of our project allowed two opportunities to estimate salmon abundance using mark recapture methods. The first opportunity used Kalskag fish wheels and gillnets for the marking event and Aniak fish wheels and gillnets for the recovery event. The second opportunity was to use both Kalskag and Aniak fish wheels and gillnets as the marking event and the upstream escapement projects as the recovery event. The population estimate whose dataset fulfilled model assumptions would be chosen. If both data sets fulfilled model assumptions the more precise estimator would be chosen. In addition the first opportunity could potentially provide inseason estimates of abundance where as the second opportunity would be a postseason estimate only. In 2002 only the fish wheel and gillnet data set could be stratified by time to meet the assumptions of the Darroch estimator for chum and coho salmon.

Sockeye salmon abundance was not estimated in 2002 because few were captured, tagged, and recovered. We think the insufficient sample size was due to the small size of the sockeye run. Both the Bethel Test fishery (CPUE lowest since inception) and subsistence harvests (64% of the average) indicated low sockeye abundance (Ward et al. 2003). Furthermore, sockeye salmon passage at the Kogrukluk River weir was 57% below the average escapement of 9,424.

Our chum salmon abundance estimate, 675,659 fish (95% CI=559,564, 791,755; SE=59,232; Table 12), and coho salmon, 316,068 fish (95% CI=193,877, 438,259; SE=62,342; Table 19), are probably biased high because of the uncertainties in the proportion of downstream migrants and mortalities of tagged fish. Although we subtracted the tagged fish that were captured or recovered at weirs down stream from our tag site, we believe not all downstream migrant fish were accounted for. While the exact degree of the positive bias is unknown, comparison of our estimate with estimates of other studies could provide insight into the relative accuracy of our estimate.

The total number of salmon counted at escapement projects (Aniak River, George River, Kogrukluk River, Tatlawiksuk River, and Takotna River) upstream from Kalskag was 447,017 chum salmon and 26,376 coho salmon. In addition, 542,172 chum salmon, SE=285,925, and 157,277 coho salmon SE=56,624 were estimated to spawn in the entire Holitna River drainage using radio telemetry (Chythlook and Evenson 2003). This results in a minimum estimate of 939,695 chum salmon and 169,152 coho salmon upstream of Kalskag. Our estimate was 264,036 fewer chum salmon than a value, which does not account for those spawning in unmonitored systems. Our estimate was 146,916 coho salmon greater and this difference represents those thought to spawn in the remaining drainage (unmonitored) upstream from Kalskag. We are uncertain whether subsistence catches and unmonitored spawning grounds would account for the difference in coho salmon.

Chythlook and Evenson (2003) indicated that abundance estimation for chum salmon in the Holitna River drainage was problematic in 2002 and as a consequence, it was not possible to directly estimate abundance for the later portion of the run or for female chum salmon. In

addition, because few radio-tagged fish migrated past the Kogrukluk weir recovery site, the estimated drainage-wide abundance was imprecise, (SE ~ 50% of the estimate). We do not believe that our estimate under represents chum salmon above Kalskag. In fact, using a conservative estimate of 256,247 (542,172-285,925) for the Holitna River drainage, the combined estimate becomes 653,770 chum salmon above the Kalskag tag site, which is much closer to the abundance point estimate of 675,659 reported in this study (Table 7). However, this discrepancy should be examined further and noted for future years.

Holding time in fish wheel live boxes has been implicated to delayed mortality in fall chum salmon on the Yukon River (Burek and Underwood, 2002; Underwood et al. 2002). A decrease in the tag recovery ratio with an increase in river mile has been observed on the Kuskokwim for coho salmon in 2001 and chum salmon but not coho salmon in 2002. We believe the decrease in tag recovery is a result of unequal tagging rather than delayed mortality. Holding time had no correlation with probability of recapture for sockeye, chum, or coho salmon in 2002 or coho salmon (Kerkvliet and Hamazaki 2002) in 2001. The addition of gillnetting for coho salmon in 2002 addressed the potential that upstream stocks pass further offshore and are less vulnerable to capture by fish wheels. As a result no such relationship was observed in 2002 for coho salmon. Therefore, we conclude that handling had little effect on mortality of tagged sockeye, chum, or coho salmon in this study. Gillnetting for chum salmon did not correct for the unequal tag recovery at upriver escapement sites. Over 70% of the tagged chum salmon recovered at the Aniak River sonar site were tagged from the left bank fish wheel at the Aniak tagging site in 2002. This needs to be addressed for 2003.

This is the first year an abundance estimate and run timing data have been documented for chum and coho salmon in the Kuskokwim River. Improvements in fish wheel design, increased drift gillnetting, and use of established fish wheel sites contributed to the increase coho salmon catch over 2001 (Kerkvliet and Hamazaki 2002). Furthermore, run timing data have confirmed traditional knowledge of salmon returning to the Kuskokwim River. The potential for this project to provide inseason run timing and abundance to managers is great. Slight changes to the project design may promote complete mixing between tagged and untagged chum salmon. Bank orientation of chum salmon tagged from the Kalskag site was not obvious at the Aniak tagging site. However, we are considering moving the Kalskag fish wheels down stream approximately 20 rkm to promote greater mixing between the two sites.

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Table 1. Number of sockeye salmon tagged and recovered at the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

Tag Site	Sockeye Salmon				
Kalskag	Tagged	Untagged	Recaptures from: Kalskag[3/]	Aniak[4/]	Total Catch
Left Bank [1/]	151	9	1	0	161
Right Bank [2/]	113	8	5	0	126
Gillnet	6	0	1	1	8
Total	270	17	7	1	295

Aniak	Tagged	Untagged	Recaptures from: Kalskag[3/]	Aniak[4/]	Total Catch
Left Bank [1/]	272	149	3	6	430
Right Bank [2/]	120	38	2	0	160
Gillnet	12	0	0	0	12
Total	404	187	5	6	602

Combined	Tagged	Untagged	Recaptures from: Kalskag[3/]	Aniak[4/]	Total Catch
Left Bank [1/]	423	158	4	6	591
Right Bank	233	46	7	0	286
Gillnet	18	0	1	1	20
Total	674	204	12	7	897

[1/] Fish wheel anchored to your left bank when facing downstream
[2/] Fish wheel anchored on right bank
[3/] Fish tagged at the Kalskag site
[4/] Fish tagged at the Aniak site

Table 2. Number of tagged sockeye salmon recovered at escapement projects located downstream and upstream from Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

River Section	Escapement Project: Distance from Tag Sites (rkm) [1]	Location	Count	Tags Recovered and Observed: Tag Site: Kalskag F [2]	Kalskag G [3]	Kalskag U [4]	Kalskag Total	Aniak F [2]	Aniak G [3]	Aniak U [4]	Aniak Total	Tag Ratio
Lower	-300	Kanektok R.	58,326	2	0	0	2	0	0	0	0	<0.000
	-198	Kwethluk R.	272	1	0	0	1	0	0	0	0	0.004
	-166	Tuluksak R.	82	1	0	0	1	1	0	0	1	0.024
Middle	52	Aniak R.	54	1	0	0	1	2	0	0	2	0.056
	166	George R.	17	2	0	0	2	2	0	0	2	0.235
	423	Kogrukluk R.	3,913	7	0	0	7	4	1	2	7	0.004
		Total	62,664	14	0	0	14	9	1	2	12	<0.000

[1] Negative distance means downstream from the tag sites.
Distance indicated is from the Kalskag site.
Add 32 rkm to calculate distance from the Aniak site to lower river escapement projects, and subtract 32 rkm to calculate distance from the Aniak site to middle and upper river escapement projects.
[2] Tagged from fish wheels
[3] Tagged from gillnets
[4] Capture gear unknown

Table 3. Number of tagged sockeye salmon recovered by subsistence, commercial and sport fishers in relation to the distance from the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

River Section	Distance from Tag Sites (rkm) [1/, 2/]	Tags Recovered			
		Subsistence	Commercial	Sport	Total
Downstream	(-27) to (-226)	6	0	0	6
Near Tag Site	0	2	0	0	2
Upstream	26 to 690	11	0	1	12
Unknown		2	0	1	3
	Total	21	0	2	23

[1/] Negative distance means downstream from the tag sites
[2/] Range of distances of recaptured fish

Table 4. Sockeye salmon travel speed (rkm/day) based on recoveries of fish tagged at the Kalskag site and recovered at the Aniak tag site and on recoveries of fish tagged at the Kalskag or Aniak site and recovered at escapement projects on the Kuskokwim River, 2002.

Tag Recoveries	Tag Dates	N	Travel Speed (rkm/day)			Travel Days		
			Mean	Median	SE	Mean	Median	Range
Aniak Tag Site	Jul. 1 – Sept. 2	5	22	27	10.7	2	1	0-9
Escapement Projects								
Aniak Sonar	Jun. 27 - Jul. 4	3	16	16	5.34	5	5	2-7
George R.	Jun. 21- Aug. 13	4	21	22	2.42	9	8	8-12
Kogrukluk R.	Jun. 17- Jul. 12	12	28	30	5.83	17	15	13-25

Table 5. Number of sockeye, chum, and coho salmon examined for secondary marks at the Aniak River sonar project and at the George, Kogrukluk, Tatlawiksuk, and Takotna River weirs on the Kuskokwim River, 2002

Escapement Project	Sockeye Salmon		Chum Salmon		Coho Salmon		Total	
	Examined	Tag Loss	Examined	Tag Loss	Examined	Tag Loss	Examined	Tag Loss
Aniak River Sonar	5	0	3,577	0	0	0	3,582	0
George River Weir	0	0	2,141	0	359	0	2,500	0
Kogrukluk River Weir	39	0	2,076	0	718	0	2,833	0
Tatlawiksuk River Weir	0	0	3,499	1	1,799	0	5,298	1
Takotna River Weir	0	0	2,245	0	2,338	0	4,583	0
Total	44	0	13,538	1	5,214	0	18,796	1

[1/] Number of fish examined for secondary marks.
[2/] Fish examined that had a secondary mark and was untagged.

Table 6. Number of chum salmon tagged and recovered at the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

Tag Site	Chum Salmon				
Kalskag	Tagged	Untagged	Recaptures from:		Total Catch
			Kalskag[3/]	Aniak[4/]	
Left Bank[1/]	2,643	273	59	12	2,987
Right Bank[2/]	5,020	409	103	6	5,538
Gillnet	159	21	1	0	181
Total	7,822	703	163	18	8,706

Aniak	Tagged	Untagged	Recaptures from:		Total Catch
			Kalskag[3/]	Aniak[4/]	
Left Bank[1/]	6,076	4,032	100	77	10,285
Right Bank[2/]	6,318	2,326	179	52	8,875
Gillnet	111	12	0	1	124
Total	12,505	6,370	279	130	19,284

Combined	Tagged	Untagged	Recaptures from:		Total Catch
			Kalskag[3/]	Aniak[4/]	
Left Bank[1/]	8,719	4,305	159	89	13,272
Right Bank[2/]	11,338	2,735	282	58	14,413
Gillnet	270	33	1	1	305
Total	20,327	7,073	442	148	27,990

[1/] Fish wheel anchored to your left bank when facing downstream
[2/] Fish wheel anchored on right bank
[3/] Fish tagged at the Kalskag site
[4/] Fish tagged at the Aniak site

Table 7. Number of tagged chum salmon recovered at escapement projects located downstream and upstream from Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

River Section	Escapement Project: Distance from Tag Sites (rkm) [1]	Location	Count	Tags Recovered and Observed: Tag Site: Kalskag F [2]	Kalskag G [3]	Kalskag U [4]	Kalskag Total	Aniak F [2]	Aniak G [3]	Aniak U [4]	Aniak Total	Tag Ratio
Lower	-198	Kwethluk R.	34,681	0	0	1	1	0	0	3	3	<0.001
	-166	Tuluksak R.	9,957	9	0	4	13	3	0	3	6	0.002
Middle	52	Aniak R.	3,577	17	0	0	17	55	0	1	56	0.020
	166	George R.	6,543	56	1	10	67	49	0	12	61	0.020
	423	Kogrukluk R.	49,494	16	0	4	20	50	0	12	62	0.002
Upper	283	Tatlawiksuk R.	24,539	53	0	6	59	54	0	10	64	0.005
	564	Takotna R.	4,366	1	1	0	2	4	0	2	6	0.002
		Total	133,157	152	2	25	179	215	0	43	258	0.003

[1] Negative distance means downstream from the tag sites.
Distance indicated is from the Kalskag site.
Add 32 rkm to calculate distance from the Aniak site to lower river escapement projects, and subtract 32 rkm to calculate distance from the Aniak site to middle and upper river escapement projects.

[2] Tagged from fish wheels

[3] Tagged from gillnets

[4] Capture gear unknown

Table 8. Number of tagged chum salmon recovered by subsistence, commercial and sport fishers in relation to the distance from the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

River Section	Distance from Tag Sites (rkm) [1/, 2/]	Tags Recovered			
		Subsistence	Commercial	Sport	Total
Downstream	(-91) to (-243)	228	20	1	249
Near Tag Site	0	90	0	0	90
Upstream	26 to 663	269	1	47	317
Unknown		22	0	0	22
	Total	609	21	48	678

[1/] Negative distance means downstream from the tag sites
[2/] Range of distances of recaptured fish

Table 9. Chum salmon travel speed (rkm/day) based on recoveries of fish tagged at the Kalskag site and recovered at the Aniak tag site and on recoveries of fish tagged at the Kalskag or Aniak site and recovered at escapement projects on the Kuskokwim River, 2002.

Tag Recoveries	Tag Dates	N	Travel Speed (rkm/day)			Travel Days		
			Mean	Median	SE	Mean	Median	Range
Aniak Site	Jun. 18 – Sept. 12	279	19	27	0.19	2	1	0-31
Escapement Projects								
Aniak Sonar	Jun. 24- Jul. 29	72	18	17	1.18	4	3	1-16
George R.	Jun. 16- Aug. 31	106	29	32	0.91	7	6	4-32
Kogrukluk R.	Jun. 16- Jul. 11	66	33	33	0.65	13	13	9-19
Tatlawiksuk R.	Jun. 15- Jul. 31	119	28	34	2.77	8	8	1-17
Takotna R.	Jun. 16- Jun. 27	6	36	35	1.79	16	17	14-18

Table 10. Length distribution of chum salmon at the Kalskag and Aniak sites and at escapement projects on the Kuskokwim River, 2002.

Location or River Section	Distance from[1] Tag Sites (rkm)	Weir Location	Range (mm)	n	Mean (mm)	Standard Error
Kalskag Site	0		250 – 850	6,524	561.1	0.484
Aniak Site	0		275 – 785	6,349	567.8	0.497
Middle	166	George River	435 – 680	1,059	570.6	1.265
Middle	423	Kogrukluk River	490 – 695	580	565.9	2.658
Upper	283	Tatlawiksuk River	400- 690	1,418	556.3	1.737
Upper	564	Takotna River	476-695	880	578.5	1.186

[1/] Distance indicated is from the Kalskag site.
Subtract 32 rkm to calculate distance from the Aniak site to middle and upper river escapement projects.

Table 11. The number of chum salmon tagged at the Kalskag site and recaptured at the Aniak site by stratum, 2002.

Tagging Stratum	Recovery Stratum			Total Recovered	Tags Released
	06/14-07/10	07/11-08/01	08/02-09/12		
06/14-07/10	59	0	0	59	2,939
07/11-08/01	0	180	0	180	4,236
08/02-09/12	0	0	40	40	537
Unmarked Catch	8,869	8,911	1,225		
Total	8,928	9,091	1,265		
P (Recapture)	0.0201	0.0425	0.0745		

Table 12. Chum salmon stratum abundance and probability of capture estimates from the Darroch model based on the Kalskag-Aniak fish wheel and gillnet data set, 2002

Strata	Abundance Estimate	Standard Error	Coefficient of Variation	Probability of Capture	Standard Error
06/14-07/10	444,735	57,708	0.13	0.007	0.009
07/11-08/01	213,941	15,787	0.074	0.020	0.002
08/02-09/12	16,982	2,642	0.156	0.032	0.005
Total	675,659	59,232	0.088		
95% CI	559,564, 791,755				

Table 13. Number of coho salmon tagged and recovered at the Kalskag and the Aniak tagging sites on the Kuskokwim River, 2002.

Tag Site	Coho Salmon				
Kalskag	Tagged	Untagged	Recaptures from:		Total Catch
			Kalskag[3/]	Aniak [4/]	
Left Bank [1/]	598	43	8	3	652
Right Bank [2/]	1,592	88	23	5	1,708
Gillnet	634	70	8	3	715
Total	2,824	201	39	11	3,075
Aniak	Tagged	Untagged	Recaptures from:		Total Catch
			Kalskag[3/]	Aniak [4/]	
Left Bank [1/]	1,159	58	25	20	1,262
Right Bank [2/]	2,022	63	15	12	2,112
Gillnet	967	47	11	10	1,035
Total	4,148	168	51	42	4,409
Combined	Tagged	Untagged	Recaptures from:		Total Catch
			Kalskag[3/]	Aniak [4/]	
Left Bank [1/]	1,757	101	33	23	1,914
Right Bank [2/]	3,614	151	38	17	3,820
Gillnet	1,601	117	19	13	1,750
Total	6,972	369	90	53	7,484

[1/] Fish wheel anchored to your left bank when facing downstream
[2/] Fish wheel anchored on right bank
[3/] Fish tagged at the Kalskag site
[4/] Fish tagged at the Aniak site

Table 14. Number tagged coho salmon recovered at escapement projects located downstream and upstream from Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

Escapement Project				Tags Recovered and Observed								
				Tag Site								Tag Ratio
River Section	Distance from Tag Sites (rkm) [1]	Location	Count	Kalskag				Aniak				
				F [2]	G [3]	U [4]	Total	F [2]	G [3]	U [4]	Total	
Lower	-198	Kwethluk R.	22,298	2	0	5	7	0	0	4	4	<0.001
	-166	Tuluksak R.	11,487	2	2	5	9	3	0	16	19	0.002
Middle	166	George R.	6,759	21	8	12	41	24	9	26	59	0.015
	423	Kogrukluk R.	14,501	78	17	13	108	75	40	26	141	0.017
Upper	283	Tatlawiksuk R.	11,132	38	14	13	65	46	24	32	102	0.015
	564	Takotna R.	3,984	15	4	0	19	23	8	2	33	0.013
		Total	70,161	156	45	48	249	171	81	106	358	0.009

[1] Negative distance means downstream from the tag sites.
Distance indicated is from the Kalskag site.
Add 32 rkm to calculate distance from the Aniak site to lower river escapement projects, and subtract 32 rkm to calculate distance from the Aniak site to middle and upper river escapement projects.

[2] Tagged from fish wheels

[3] Tagged from gillnets

[4] Capture gear unknown

Table 15. Number of tagged coho salmon recovered by subsistence, commercial, and sport fishers in relation to the distance from the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

River Section	Distance from Tag Sites (rkm) [1/, 2/]	Tags Recovered and Observed			
		Subsistence	Commercial	Sports	Total
Downstream	(-118) to (-232)	36	11	0	47
Near Tag Site	0	21	0	0	21
Upstream	26 to 1,162	117	0	53	170
Unknown		6	0	0	6
	Total	180	11	53	244

[1/] Negative distance means downstream from the tag sites
[2/] Range of distances of recaptured fish

Table 16. Coho salmon travel speed (rkm/day) based on recoveries of fish tagged at the Kalskag site and recovered at the Aniak tag site and on recoveries of fish tagged at the Kalskag or Aniak site and recovered at escapement projects on the Kuskokwim River, 2002.

Tag Recoveries	Tag Dates	N	Travel Speed (rkm/day)			Travel Days		
			Mean	Median	SE	Mean	Median	Range
Aniak Site	Jun. 28 – Sept. 11	51	14	14	10.682	3	2	0-19
Escapement Projects								
George R.	Aug. 4- Sep. 4	62	13	12	0.756	17	15	6-34
Kogrukluk R.	Jul. 8- Sep. 9	210	26	25	0.416	18	17	10-35
Tatlawiksuk R.	Jul. 16- Sep. 8	122	23	22	0.671	15	13	7-47
Takotna R.	Jul. 28- Sep. 3	50	29	28	0.836	21	20	12-35

Table 17. Length distribution of coho salmon at tag sites and at escapement projects on the Kuskokwim River, 2002.

Location or River Section	Distance from Tag Sites (rkm)	Weir Location	Range (mm)	n	Mean (mm)	Standard Error
Kalskag Site	0		260 - 860	2,803	556.1	0.960
Aniak Site	0		320 - 860	4,096	558.2	1.753
Middle	166	George River	420 - 655	83	545.4	5.083
Middle	423	Kogrukluk River	455 - 655	474	560.7	1.487
Upper	283	Tatlawiksuk River	384 - 675	639	561.3	1.670
Upper	564	Takotna River	405 - 810	391	561.0	2.355

Table 18. The number of tagged coho salmon recaptured by tagging and recovery stratum, the number of tagged fish released in each tagging stratum, and the number of unmarked fish caught at the Aniak site by recovery stratum on the Kuskokwim River, 2002

Tagging Stratum	Recovery Stratum			Total Recovered	Tags Released
	07/28-08/07	08/08-08/23	08/24-09/12		
07/28-08/07	7	0	0	7	575
08/08-08/23	0	12	0	12	1,074
08/24-09/12	0	0	32	32	1,090
Unmarked Catch	902	2,108	1,355		
Total	909	2,120	1,387		
P (Recapture)	0.0120	0.0110	0.0285		

Table 19. Coho salmon stratum abundance and probability of capture estimates from the Darroch model based on the Kalskag-Aniak fish wheel and gillnet data set, Kuskokwim River, 2002

Strata	Abundance Estimate	Standard Error	Coefficient of Variation	Probability of Capture	Standard Error
07/28-08/07	75,576	28,455	0.352	0.008	0.003
08/08-08/23	191,860	55,228	0.266	0.006	0.002
08/24-09/12	48,631	8,497	0.186	0.023	0.004
Total	316,068	62,342	0.196		
95% CI	193,877; 438,259				

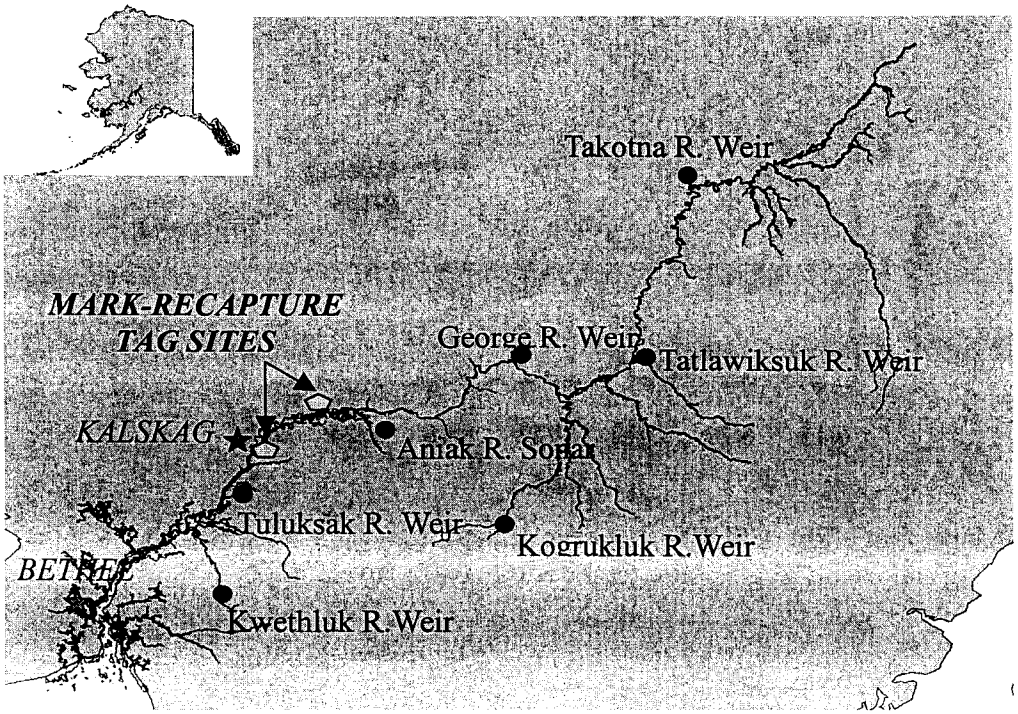

Figure 1. Locations of tagging and weir sites on the Kuskokwim River, 2002.

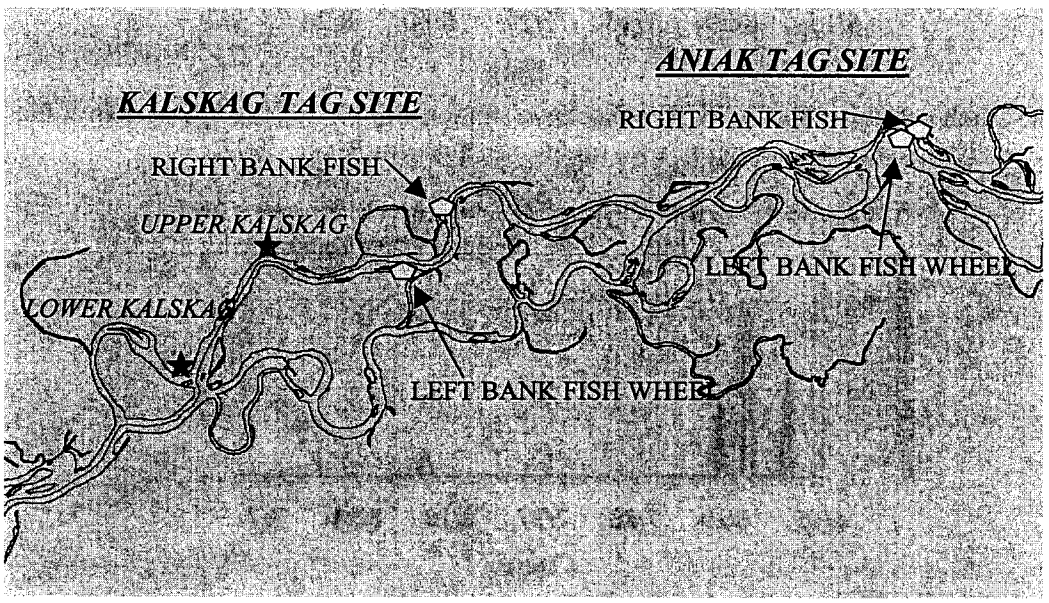

Figure 2. Location of fish wheels at tagging sites on the Kuskokwim River, 2002.

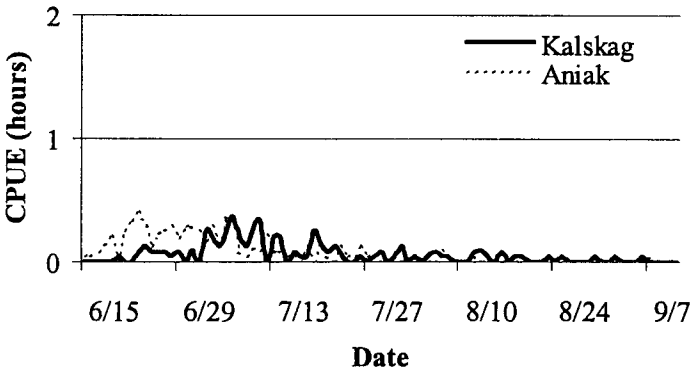

Figure 3. Catch per unit effort (CPUE) of sockeye salmon from right bank fish wheels at the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

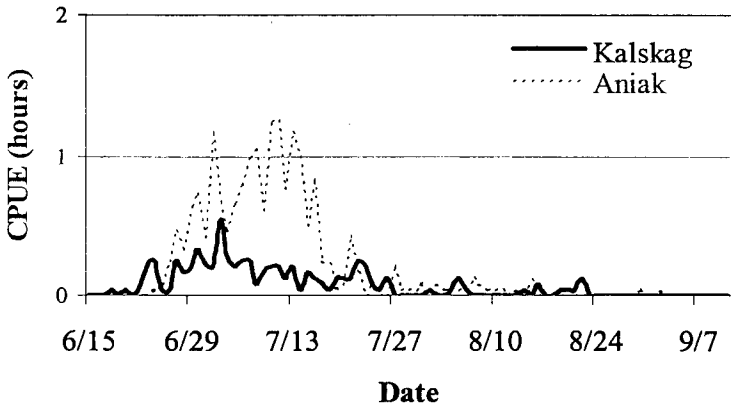

Figure 4. Catch per unit effort (CPUE) of sockeye salmon from left bank fish wheels at the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

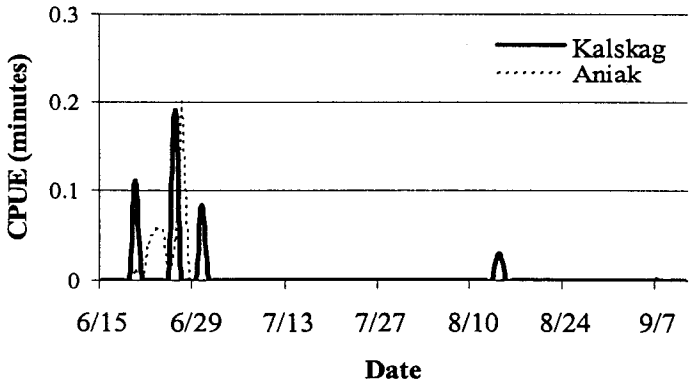

Figure 5. Catch per unit effort (CPUE) of sockeye salmon from gillnets at the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

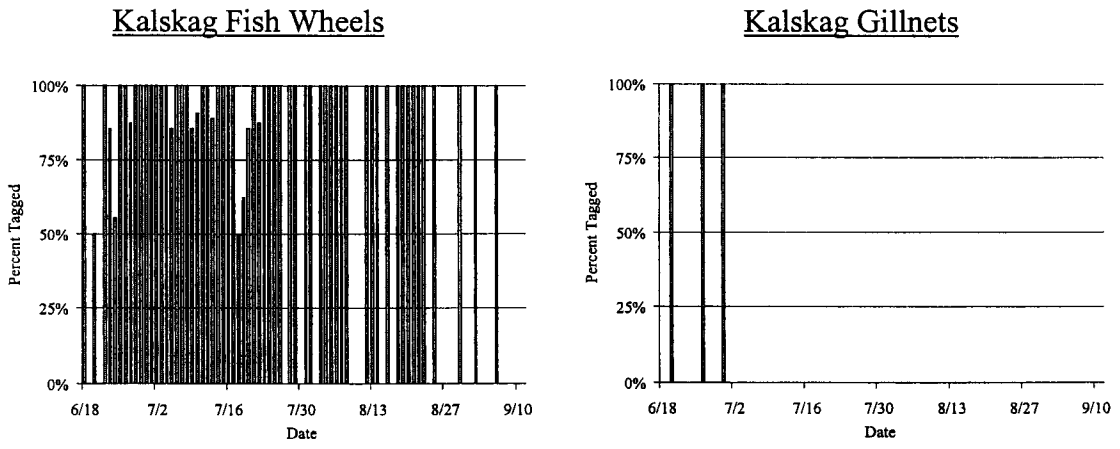

Figure 6. Percent of sockeye salmon tagged by date from fish wheels and gillnets at the Kalskag site on the Kuskokwim River, 2002.

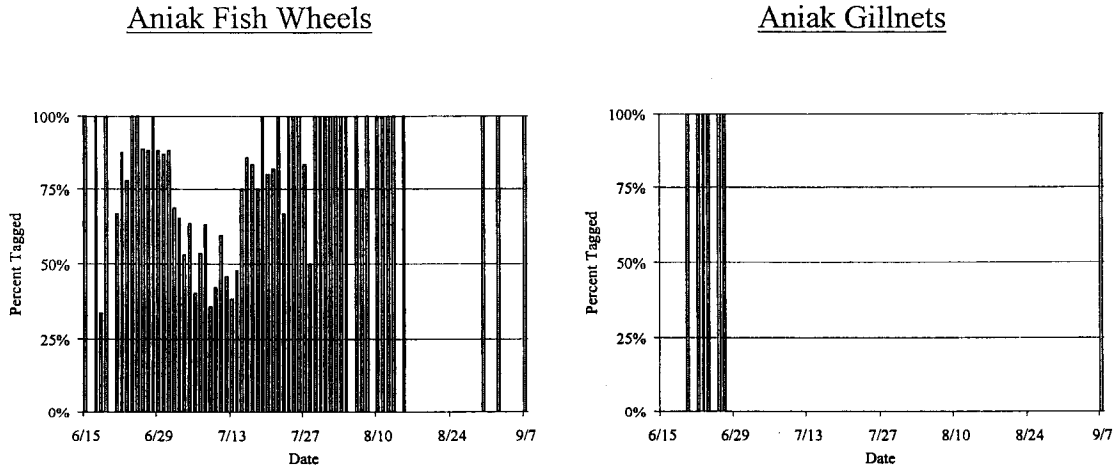

Figure 7. Percent of sockeye salmon tagged by date from fish wheels and gillnets at the Aniak site on the Kuskokwim River, 2002.

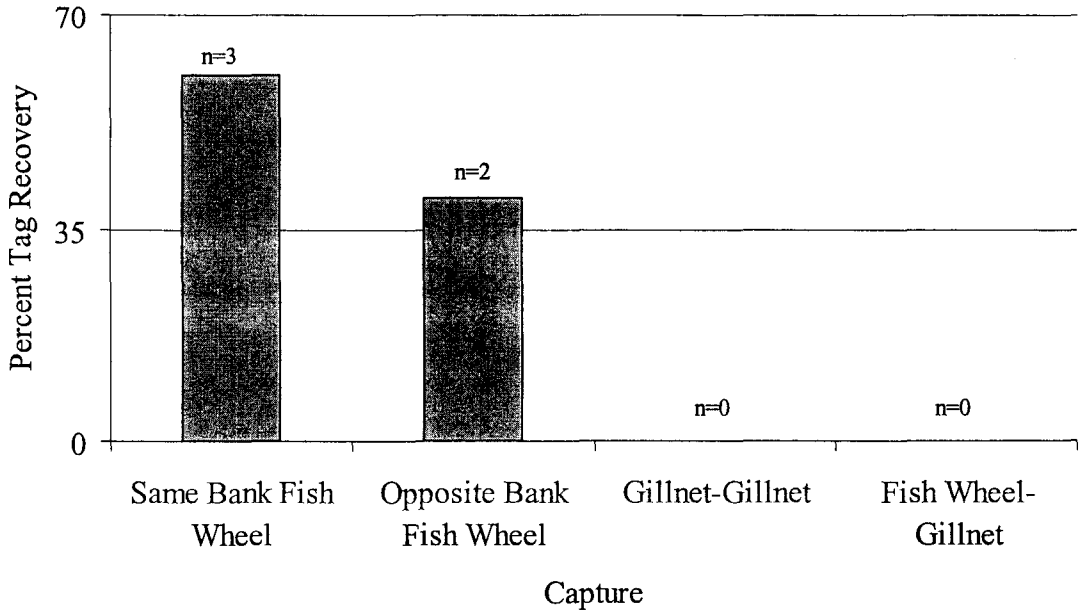

Figure 8. Percentage of sockeye salmon tagged at the Kalskag site and recovered in fish wheels or gillnets at the Aniak site on the Kuskokwim River, 2002.

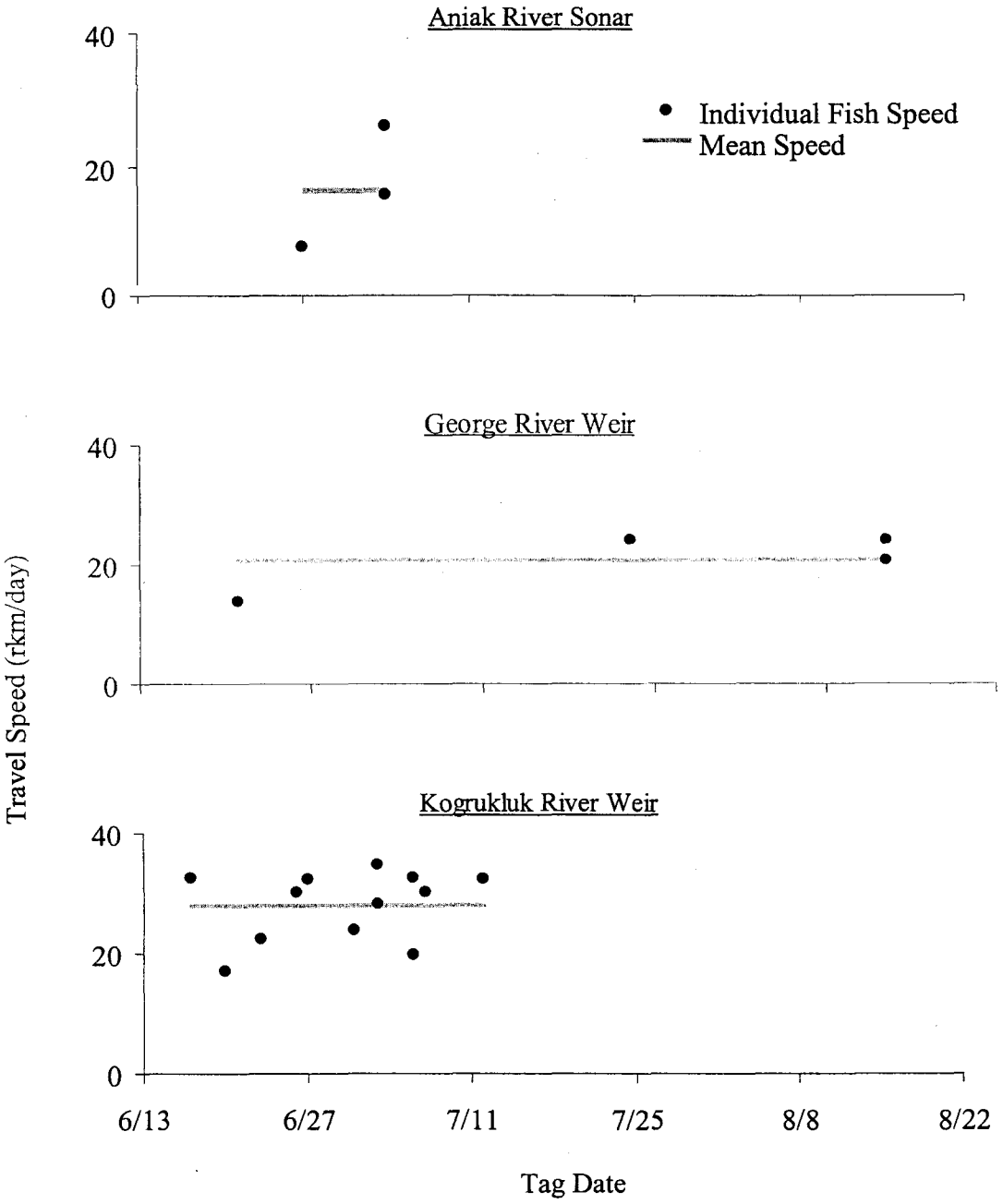

Figure 9. Travel speed (rkm/day) of tagged sockeye salmon from the Kalskag and Aniak tagging sites to the Aniak sonar site and the George and Kogrukluk River weirs on the Kuskokwim River, 2002.

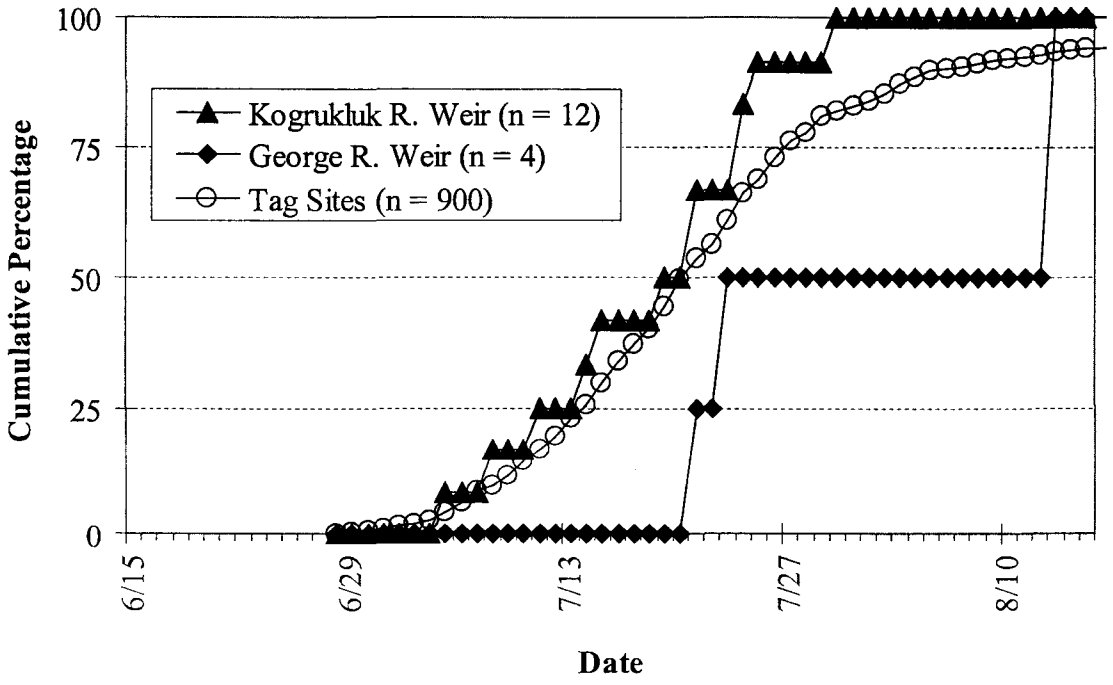

Figure 10. Cumulative percentage of recaptured tagged sockeye salmon at the Kogrukluk River weir, George River weir, and of the total sockeye salmon captured at the Kalskag-Aniak tag sites on the Kuskokwim River, 2002.

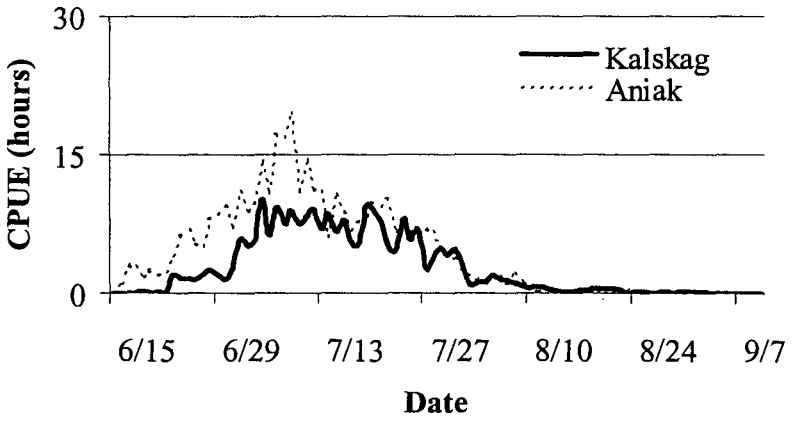

Figure 11. Catch per unit effort (CPUE) of chum salmon from right bank fish wheels at the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

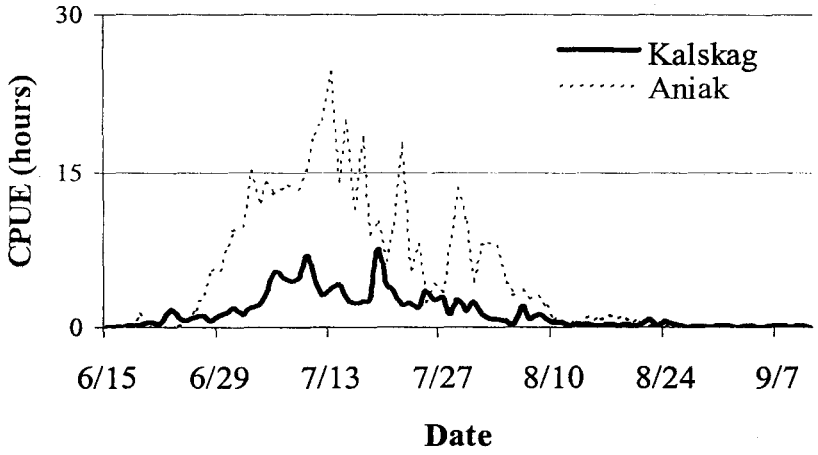

Figure 12. Catch per unit effort (CPUE) of chum salmon from left bank fish wheels at the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

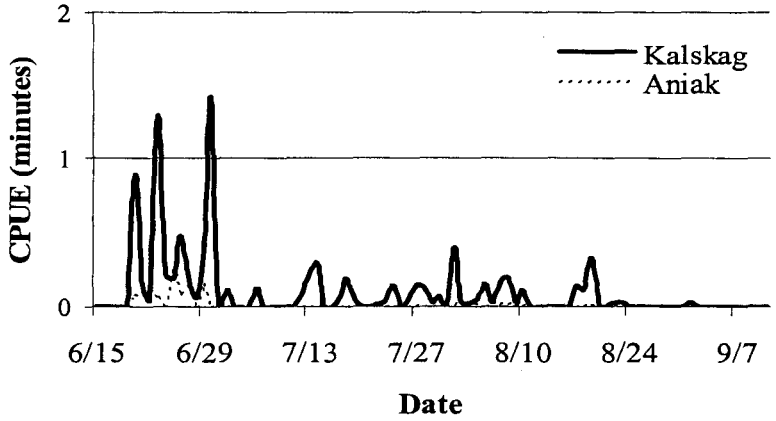

Figure 13. Catch per unit effort (CPUE) of chum salmon from gillnets at the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

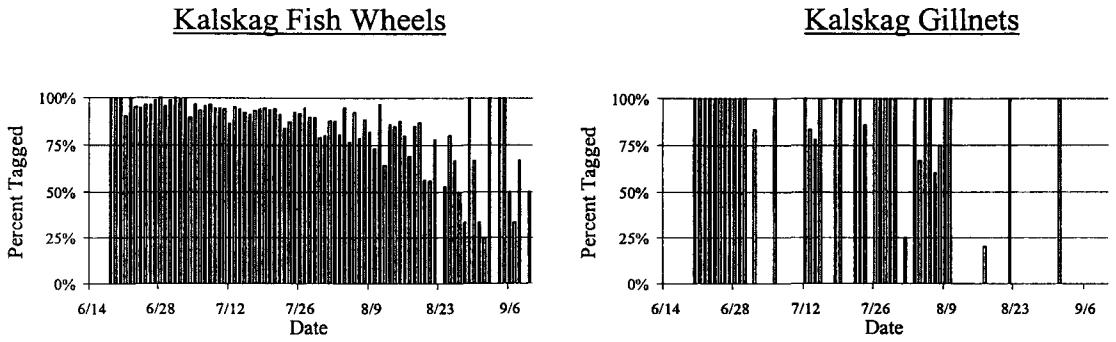

Figure 14. Percent of chum salmon tagged by date at the Kalskag site on the Kuskokwim River, 2002.

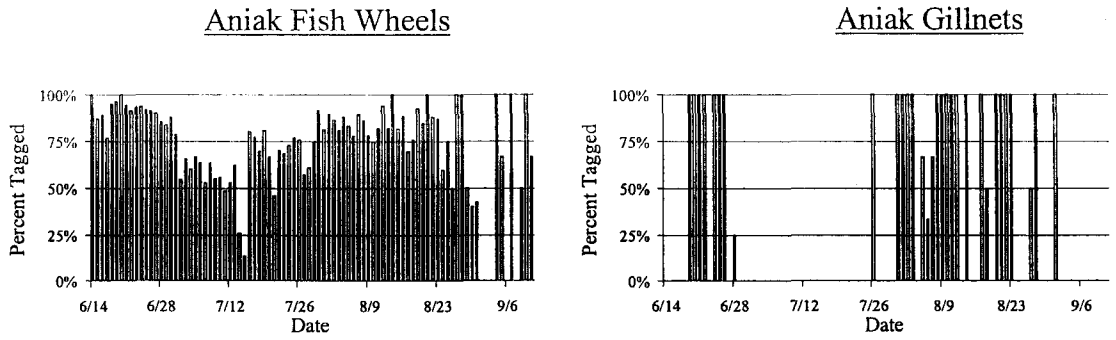

Figure 15. Percent of chum salmon tagged by date at the Aniak site on the Kuskokwim River, 2002.

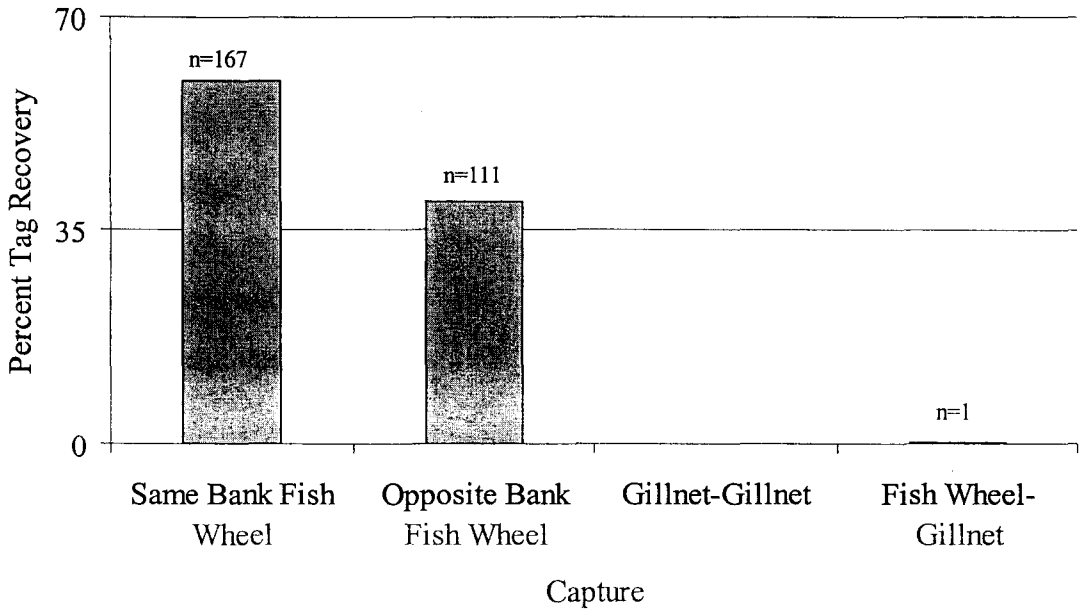

Figure 16. Percentage of chum salmon tagged at the Kalskag site and recovered in fish wheels or gillnets at the Aniak site on the Kuskokwim River, 2002.

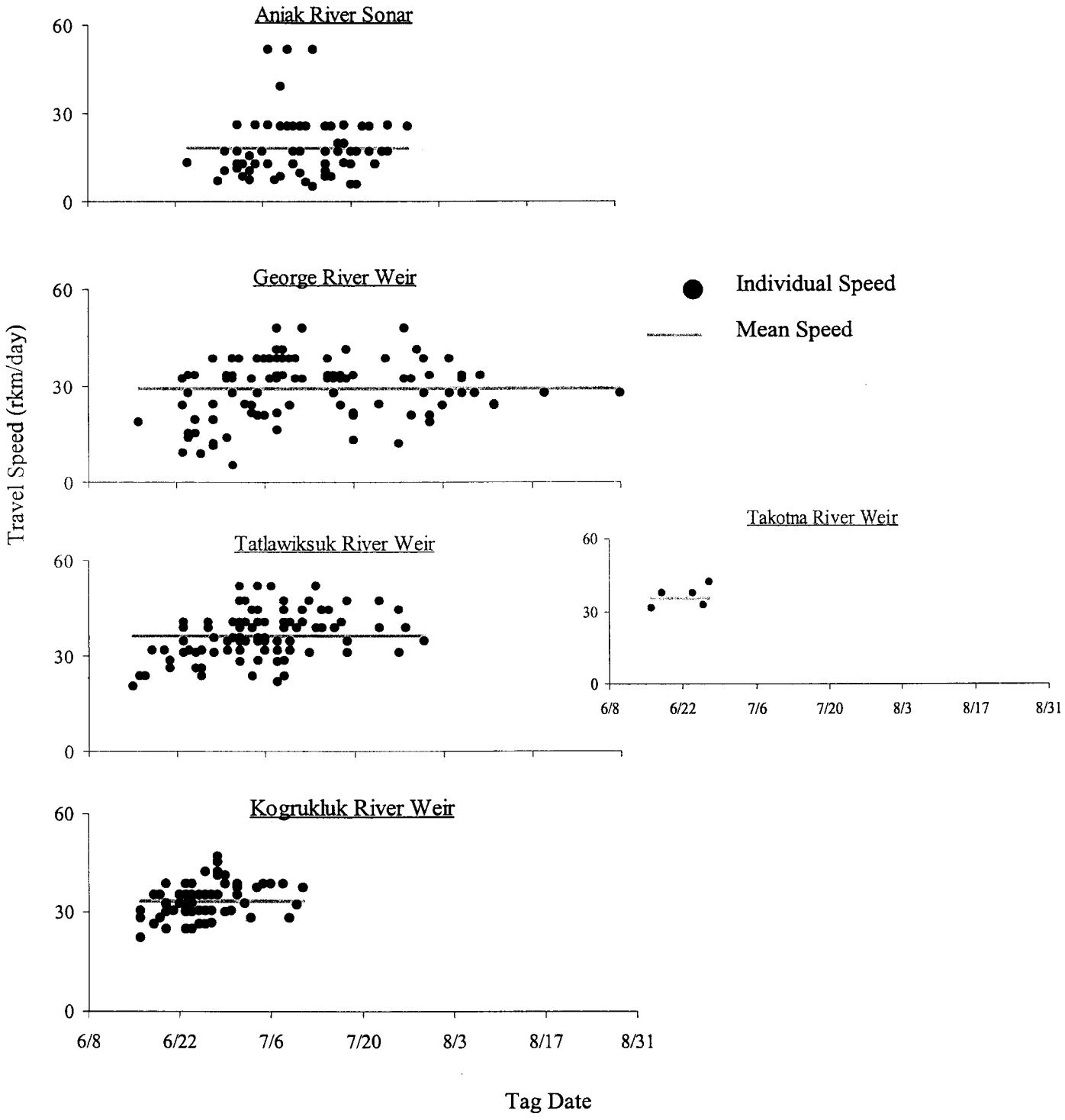

Figure 17. Travel speed (rkm/day) of tagged chum salmon from the Kalskag and Aniak tag sites to the Aniak River sonar site and the George, Kogrukluk, Tatlawiksuk, and Takotna River weirs on the Kuskokwim River, 2002.

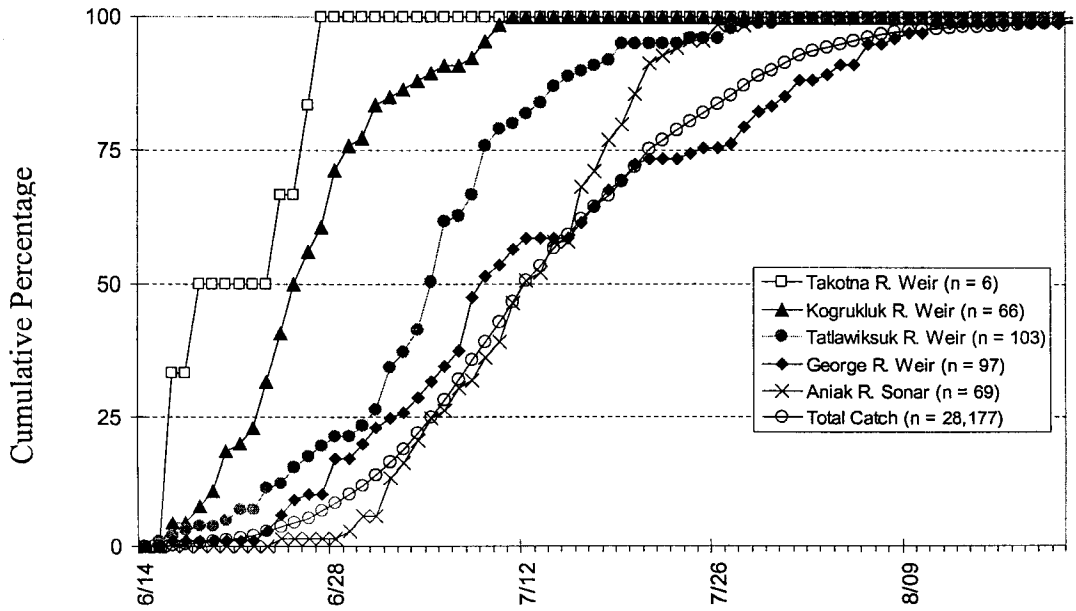

Figure 18. Cumulative percentage of recaptured tagged chum salmon at the Takotna River weir, Kogrukluk River weir, Tatlawiksuk River weir, George River weir, Aniak River sonar site, and of the total chum salmon captured at the Kalskag-Aniak tag sites on the Kuskokwim River, 2002.

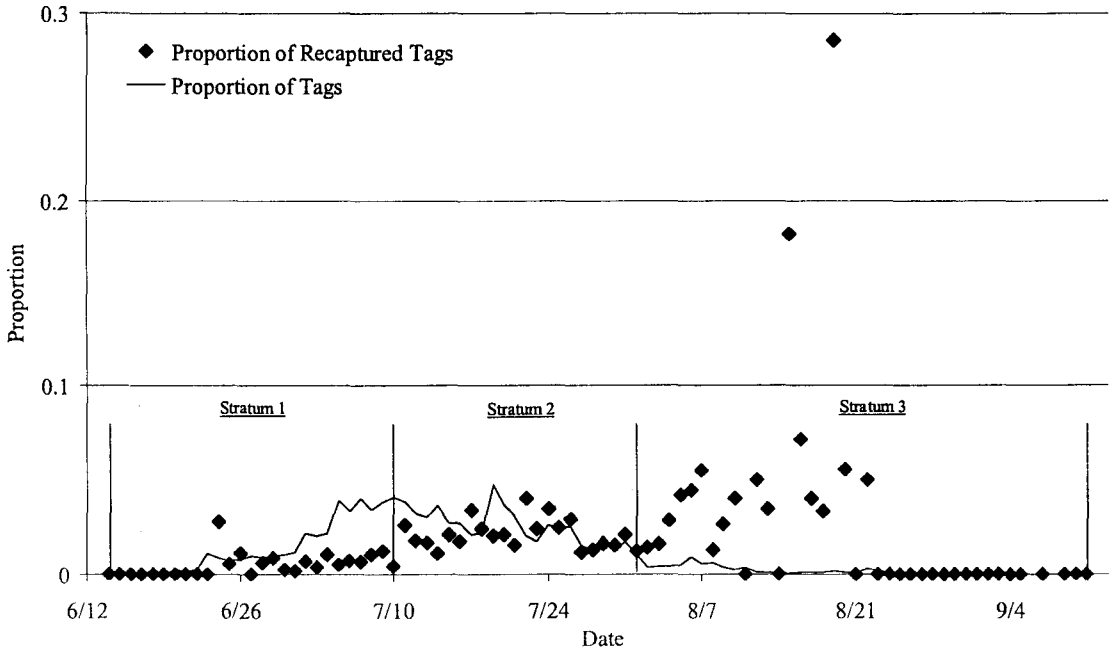

Figure 19. Proportion of chum salmon tagged at the Kalskag site, of chum recaptured at the Aniak site, and strata used to estimate chum salmon abundance on the Kuskokwim River, 2002.

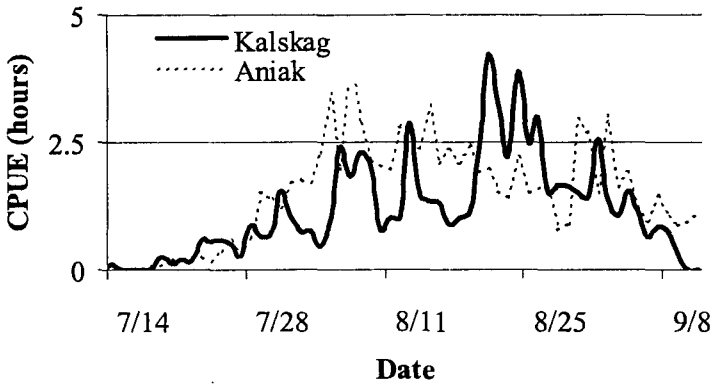

Figure 20. Catch per unit effort (CPUE) of coho salmon from right bank fish wheels at the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

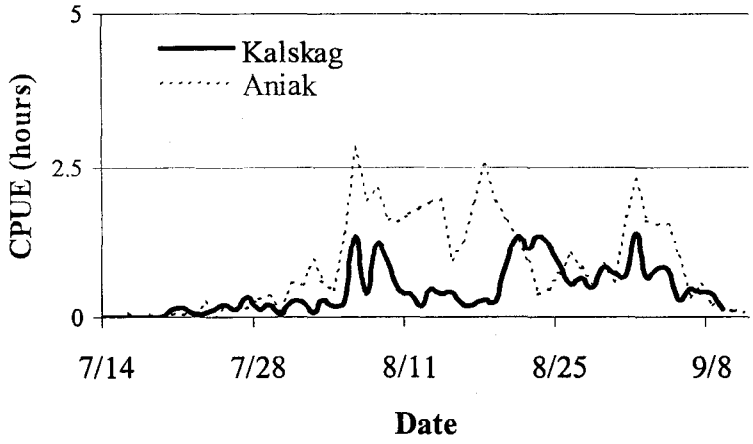

Figure 21. Catch per unit effort (CPUE) of coho salmon from left bank fish wheels at the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

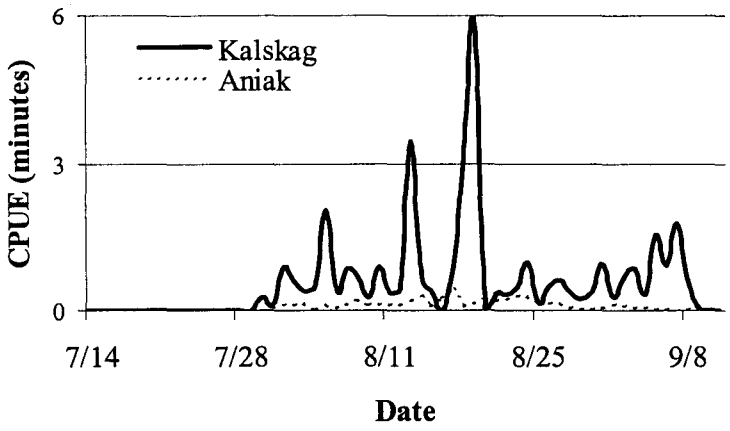

Figure 22. Catch per unit effort (CPUE) of coho salmon from gillnets at the Kalskag and Aniak tagging sites on the Kuskokwim River, 2002.

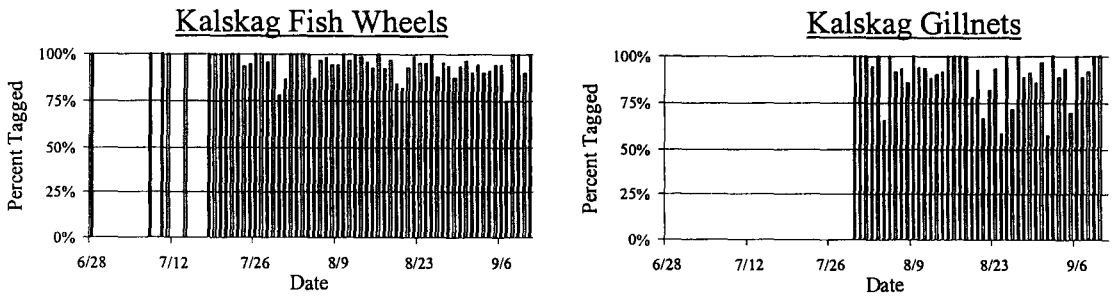

Figure 23. Percent of coho salmon tagged by date at the Kalskag site on the Kuskokwim River, 2002.

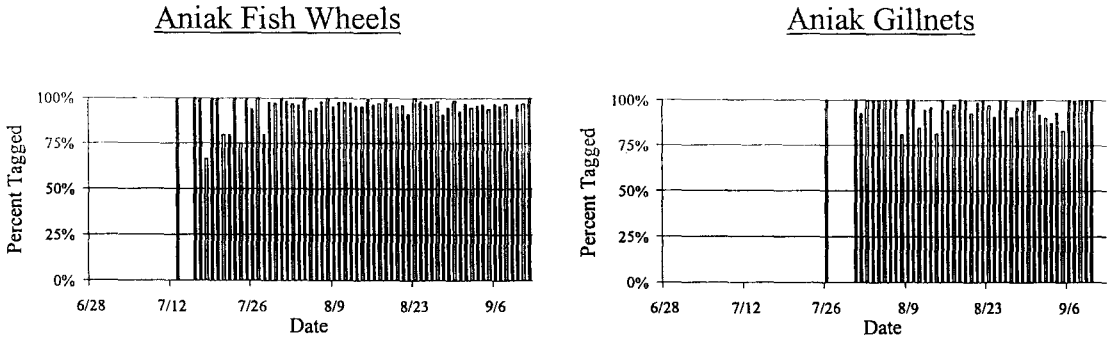

Figure 24. Percent of coho salmon tagged by date at the Aniak site on the Kuskokwim River, 2002.

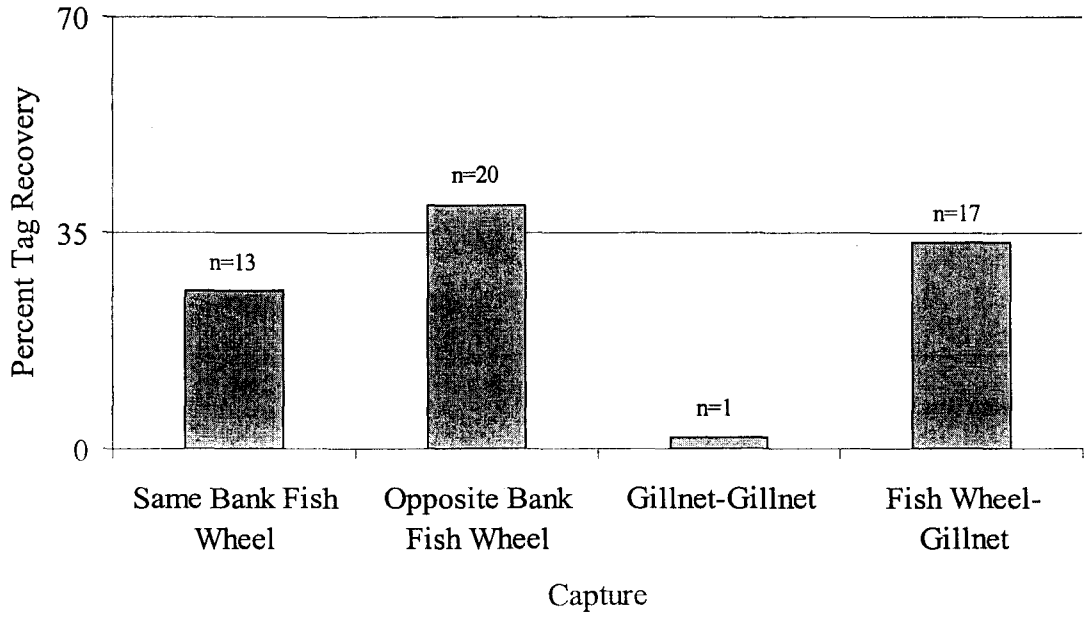

Figure 25. Percentage of coho salmon tagged at the Kalskag site and recovered in fish wheels or gillnets at the Aniak site on the Kuskokwim River, 2002.

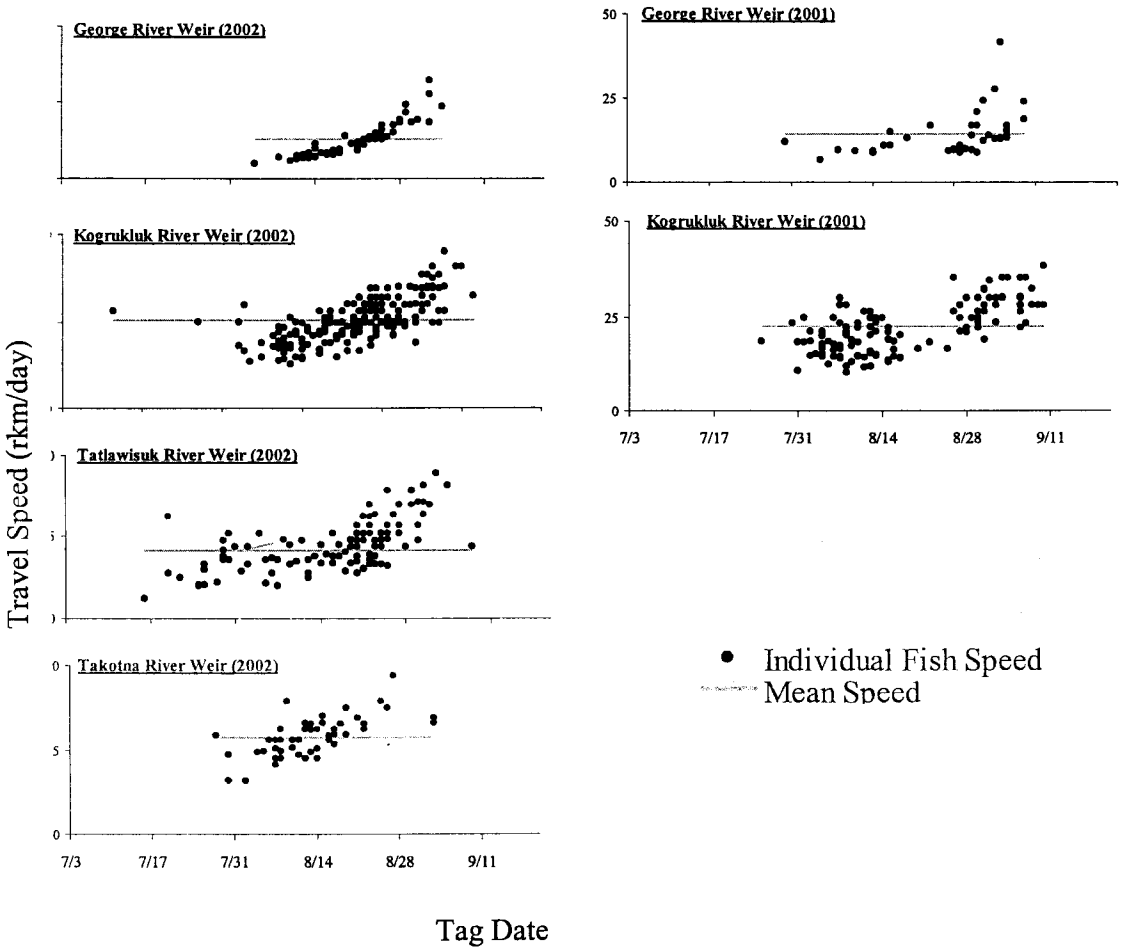

Figure 26. Travel speed (rkm/day) of tagged coho salmon from the Kalskag and Aniak tag sites to the upstream escapement projects on the Kuskokwim River, 2002.

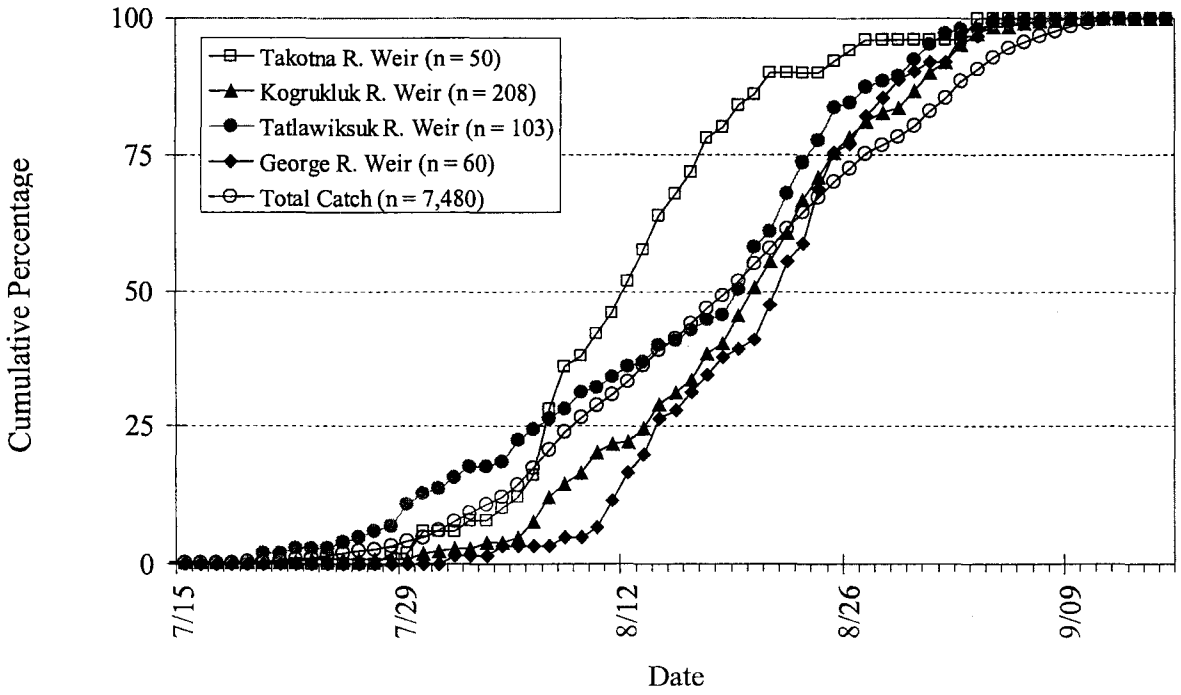

Figure 27. Cumulative percentage of recaptured tagged coho salmon at the Takotna River weir, Kogrukluk River weir, Tatlawiksuk River weir, and George River weir, and of the total of coho salmon captured at the Kalskag-Aniak tag sites on the Kuskokwim River, 2002.

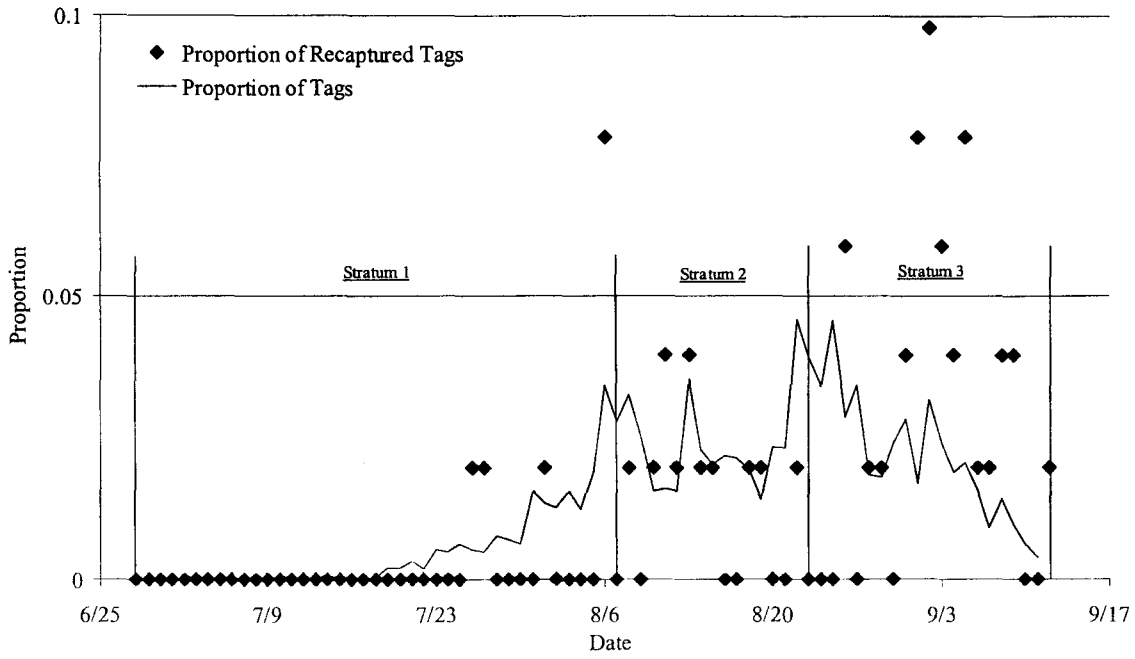

Figure 28. Proportion of coho salmon tagged at the Kalskag site, of coho recaptured at the Aniak site, and strata used to estimate coho salmon abundance on the Kuskokwim River, 2002.

APPENDICES

Appendix A:

Appendix A1. Daily summary of tagged, untagged, and recaptured sockeye salmon at the Kalskag site on the Kuskokwim River, 2002.

Kalskag										
Date	Capture Gear						Tag Site/ Recapture Site		Total	Cumm. % Catch
	Fish Wheel				Gillnet					
	Tagged		Un-Tagged				Kalskag/	Aniak/		
	RB[1/]	LB[2/]	RB[1/]	LB[2/]	Tagged	Un-Tagged	Kalskag	Kalskag		
18-Jun	0	1	0	0	0	0	0	0	1	0
19-Jun	0	0	0	0	0	0	0	0	0	0
20-Jun	1	0	0	1	1	0	0	0	3	1
21-Jun	0	0	0	0	0	0	0	0	0	1
22-Jun	0	2	0	0	0	0	0	0	2	2
23-Jun	1	5	1	0	0	0	0	0	7	4
24-Jun	2	3	1	3	0	0	0	0	9	7
25-Jun	2	1	0	0	0	0	0	0	3	8
26-Jun	2	1	0	0	4	0	0	0	7	11
27-Jun	1	6	1	0	0	0	0	0	8	14
28-Jun	1	4	0	0	0	0	0	0	5	15
29-Jun	2	5	0	0	0	0	0	0	7	18
30-Jun	0	8	0	0	1	0	0	0	9	21
01-Jul	2	4	0	0	0	0	1	0	7	23
02-Jul	0	5	0	0	0	0	0	0	5	25
03-Jul	6	11	0	0	0	0	0	1	18	31
04-Jul	5	7	0	0	0	0	0	0	12	35
05-Jul	2	4	0	1	0	0	1	0	8	38
06-Jul	6	6	0	0	0	0	0	0	12	42
07-Jul	9	6	0	0	0	0	0	0	15	47
08-Jul	5	2	0	0	0	0	0	0	7	49
09-Jul	2	4	1	0	0	0	0	0	7	52
10-Jul	5	5	1	0	0	0	0	0	11	55
11-Jul	7	5	0	0	0	0	1	0	13	60
12-Jul	0	3	0	0	0	0	0	0	3	61
13-Jul	4	4	0	1	0	0	1	0	10	64
14-Jul	5	1	0	0	0	0	0	0	6	66
15-Jul	0	4	0	0	0	0	0	0	4	67
16-Jul	2	3	0	0	0	0	0	0	5	69
17-Jul	1	2	0	0	0	0	0	0	3	70
18-Jul	1	0	0	1	0	0	0	0	2	71
19-Jul	3	2	2	1	0	0	1	0	9	74
20-Jul	3	3	1	0	0	0	0	0	7	76
21-Jul	2	3	0	0	0	0	0	0	5	78
22-Jul	2	5	0	1	0	0	1	0	9	81
23-Jul	2	5	0	0	0	0	0	0	7	83
24-Jul	0	2	0	0	0	0	0	0	2	84
25-Jul	0	1	0	0	0	0	0	0	1	84
26-Jul	0	3	0	0	0	0	0	0	3	85
27-Jul	0	0	0	0	0	0	0	0	0	85
28-Jul	1	0	0	0	0	0	0	0	1	86
29-Jul	2	0	0	0	0	0	0	0	2	86
30-Jul	0	0	0	0	0	0	0	0	0	86
31-Jul	1	1	0	0	0	0	0	0	2	87

Appendix A1. (Continued)

Kalskag										
Date	Capture Gear						Tag Site/ Recapture Site		Total	Cumm. % Catch
	Fish Wheel				Gillnet					
	Tagged		Un-Tagged		Tagged	Un-Tagged	Kalskag/	Aniak/		
	RB[1/]	LB[2/]	RB[1/]	LB[2/]			Kalskag	Kalskag		
01-Aug	3	0	0	0	0	0	0	0	3	88
02-Aug	0	0	0	0	0	0	0	0	0	88
03-Aug	1	1	0	0	0	0	0	0	2	89
04-Aug	0	3	0	0	0	0	0	0	3	90
05-Aug	1	1	0	0	0	0	0	0	2	91
06-Aug	2	0	0	0	0	0	0	0	2	91
07-Aug	1	0	0	0	0	0	0	0	1	92
08-Aug	1	0	0	0	0	0	0	0	1	92
09-Aug	0	0	0	0	0	0	0	0	0	92
10-Aug	0	0	0	0	0	0	0	0	0	92
11-Aug	0	0	0	0	0	0	0	0	0	92
12-Aug	2	0	0	0	0	0	0	0	2	93
13-Aug	2	1	0	0	0	0	0	0	3	94
14-Aug	1	0	0	0	0	0	1	0	2	94
15-Aug	0	2	0	0	0	0	0	0	2	95
16-Aug	2	0	0	0	0	0	0	0	2	96
17-Aug	0	0	0	0	0	0	0	0	0	96
18-Aug	1	1	0	0	0	0	0	0	2	96
19-Aug	1	1	0	0	0	0	0	0	2	97
20-Aug	0	1	0	0	0	0	0	0	1	97
21-Aug	0	3	0	0	0	0	0	0	3	98
22-Aug	0	0	0	0	0	0	0	0	0	98
23-Aug	1	0	0	0	0	0	0	0	1	99
24-Aug	0	0	0	0	0	0	0	0	0	99
25-Aug	1	0	0	0	0	0	0	0	1	99
26-Aug	0	0	0	0	0	0	0	0	0	99
27-Aug	0	0	0	0	0	0	0	0	0	99
28-Aug	0	0	0	0	0	0	0	0	0	99
29-Aug	0	0	0	0	0	0	0	0	0	99
30-Aug	1	0	0	0	0	0	0	0	1	99
31-Aug	0	0	0	0	0	0	0	0	0	99
01-Sep	0	0	0	0	0	0	0	0	0	99
02-Sep	1	0	0	0	0	0	0	0	1	100
03-Sep	0	0	0	0	0	0	0	0	0	100
04-Sep	0	0	0	0	0	0	0	0	0	100
05-Sep	0	0	0	0	0	0	0	0	0	100
06-Sep	1	0	0	0	0	0	0	0	0	100
06-Sep	0	0	0	0	0	0	0	0	1	100
Total	**113**	**151**	**8**	**9**	**6**	**0**	**7**	**1**	**295**	

[1/] Right Bank Fish Wheel when facing downstream
[2/] Left Bank Fish Wheel

Appendix A2. Daily summary of tagged, untagged, and recaptured sockeye salmon at the Aniak site on the Kuskokwim River, 2002.

Aniak										
Date	Capture Gear						Tag Site/ Recapture Site		Total	Cumm. % Catch
	Fish Wheel				Gillnet					
	Tagged		Un-Tagged				Kalskag/	Aniak/		
	RB[1/]	LB[2/]	RB[1/]	LB[2/]	Tagged	Un-Tagged	Aniak	Aniak		
15-Jun	1	0	0	0	0	0	0	0	1	0
16-Jun	0	0	1	0	0	0	0	0	1	0
17-Jun	2	0	0	0	0	0	0	0	2	1
18-Jun	1	0	2	0	0	0	0	0	3	1
19-Jun	5	0	0	0	0	0	0	0	5	2
20-Jun	0	0	0	0	1	0	0	0	1	2
21-Jun	4	0	2	0	0	0	0	0	6	3
22-Jun	7	0	1	0	4	0	0	0	12	5
23-Jun	7	0	2	0	2	0	0	0	11	7
24-Jun	7	1	0	0	1	0	0	0	9	8
25-Jun	3	2	0	0	0	0	0	0	5	9
26-Jun	5	3	0	1	2	0	0	1	12	11
27-Jun	6	9	0	2	1	0	0	0	18	14
28-Jun	7	8	0	0	0	0	0	0	15	17
29-Jun	4	11	0	2	0	0	0	0	17	20
30-Jun	6	14	1	2	0	0	0	0	23	23
01-Jul	7	8	0	2	0	0	0	0	17	26
02-Jul	5	17	1	9	0	0	0	1	33	32
03-Jul	2	11	2	5	0	0	0	0	20	35
04-Jul	2	7	5	3	0	0	0	1	18	38
05-Jul	2	10	1	6	0	0	0	0	19	41
06-Jul	3	7	6	9	0	0	0	0	25	45
07-Jul	4	13	4	11	0	0	0	0	32	51
08-Jul	2	15	0	10	0	0	0	0	27	55
09-Jul	1	4	0	9	0	0	0	0	14	57
10-Jul	1	12	1	17	0	0	1	0	32	63
11-Jul	2	17	0	13	0	0	0	0	32	68
12-Jul	0	10	5	7	0	0	0	0	22	72
13-Jul	1	10	1	17	0	0	0	1	30	77
14-Jul	1	9	1	10	0	0	0	1	22	80
15-Jul	1	8	0	3	0	0	0	1	13	83
16-Jul	1	17	0	3	0	0	0	0	21	86
17-Jul	0	5	0	1	0	0	0	0	6	87
18-Jul	3	3	0	2	0	0	0	0	8	88
19-Jul	0	1	0	0	0	0	0	0	1	89
20-Jul	3	1	0	1	0	0	0	0	5	89
21-Jul	1	8	0	2	0	0	0	0	11	91
22-Jul	0	4	0	0	0	0	0	0	4	92
23-Jul	2	0	1	0	0	0	0	0	3	92
24-Jul	1	1	0	0	0	0	0	0	2	93
25-Jul	1	0	0	0	0	0	0	0	1	93
26-Jul	3	0	0	0	0	0	0	0	3	93
27-Jul	1	4	0	1	0	0	0	0	6	94
28-Jul	0	1	1	0	0	0	0	0	2	95
29-Jul	0	1	0	0	0	0	0	0	1	95
30-Jul	0	1	0	0	0	0	0	0	1	95
31-Jul	1	2	0	0	0	0	0	0	3	96
01-Aug	0	1	0	0	0	0	0	0	1	96
02-Aug	0	2	0	0	0	0	0	0	2	96
03-Aug	0	1	0	0	0	0	0	0	1	96
04-Aug	0	1	0	0	0	0	0	0	1	96
05-Aug	0	0	0	0	0	0	1	0	1	97
06-Aug	0	1	0	0	0	0	0	0	1	97

Appendix A2. (Continued)

Aniak										
Date	Capture Gear						Tag Site/ Recapture Site		Total	Cumm. % Catch
	Fish Wheel				Gillnet					
	Tagged		Un-Tagged				Kalskag/	Aniak/		
	RB[1/]	LB[2/]	RB[1/]	LB[2/]	Aniak	Aniak	Aniak	Aniak		
07-Aug	1	2	0	1	0	0	1	0	5	98
08-Aug	1	2	0	0	0	0	0	0	3	98
09-Aug	0	0	0	0	0	0	0	0	0	98
10-Aug	0	1	0	0	0	0	0	0	1	98
11-Aug	0	1	0	0	0	0	0	0	1	98
12-Aug	1	0	0	0	0	0	0	0	1	99
13-Aug	0	1	0	0	0	0	0	0	1	99
14-Aug	0	0	0	0	0	0	0	0	0	99
15-Aug	0	2	0	0	0	0	0	0	2	99
16-Aug	0	0	0	0	0	0	0	0	0	99
17-Aug	0	0	0	0	0	0	0	0	0	99
18-Aug	0	0	0	0	0	0	0	0	0	99
19-Aug	0	0	0	0	0	0	0	0	0	99
20-Aug	0	0	0	0	0	0	0	0	0	99
21-Aug	0	0	0	0	0	0	0	0	0	99
22-Aug	0	0	0	0	0	0	0	0	0	99
23-Aug	0	0	0	0	0	0	1	0	1	99
24-Aug	0	0	0	0	1	0	0	0	1	99
25-Aug	0	0	0	0	0	0	0	0	0	99
26-Aug	0	0	0	0	0	0	0	0	0	99
27-Aug	0	0	0	0	0	0	0	0	0	99
28-Aug	0	0	0	0	0	0	0	0	0	99
29-Aug	0	0	0	0	0	0	0	0	0	99
30-Aug	0	1	0	0	0	0	0	0	1	100
31-Aug	0	0	0	0	0	0	0	0	0	100
01-Sep	0	0	0	0	0	0	0	0	0	100
02-Sep	0	1	0	0	0	0	0	0	1	100
03-Sep	0	0	0	0	0	0	1	0	1	100
04-Sep	0	0	0	0	0	0	0	0	0	100
05-Sep	0	0	0	0	0	0	0	0	0	100
06-Sep	0	0	0	0	0	0	0	0	0	100
07-Sep	1	0	0	0	0	0	0	0	1	100
Total	**120**	**272**	**38**	**149**	**12**	**0**	**5**	**6**	**602**	

[1/] Right Bank Fish Wheel when facing downstream
[2/] Left Bank Fish Wheel

Appendix B. Number of recovered tags from sockeye salmon by subsistence, commercial, and sport fishers at locations downstream and upstream from the Kalskag and Aniak tag sites on the Kuskokwim River, 2002.

Community	Fishery Type									Grand Total
	Subsistence			Commercial			Sports			
	Tag Site			Tag Site			Tag Site			
Downstream	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Napakiak	0	1	1	0	0	0	0	0	0	1
Bethel	1	0	1	0	0	0	0	0	0	1
Kwethluk	0	1	1	0	0	0	0	0	0	1
Akiachak	1	0	1	0	0	0	0	0	0	1
Akiak	1	0	1	0	0	0	0	0	0	1
Tuluksak	0	1	1	0	0	0	0	0	0	1
Total	**3**	**3**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**6**
Near Tag Sites	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Kalskag	1	0	1	0	0	0	0	0	0	1
Aniak	1	0	1	0	0	0	0	0	0	1
Total	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Upstream	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Aniak	2	2	4	0	0	0	1	0	1	5
Georgetown	0	1	1	0	0	0	0	0	0	1
Red Devil	1	0	1	0	0	0	0	0	0	1
Holitna	1	0	1	0	0	0	0	0	0	1
Stony River	2	2	4	0	0	0	0	0	0	4
Total	**6**	**5**	**11**	**0**	**0**	**0**	**1**	**0**	**1**	**12**
Unknown	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Total	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**1**	**1**	**3**
Combined	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Total	**13**	**8**	**21**	**0**	**0**	**0**	**1**	**1**	**2**	**23**

Appendix C:

Appendix C1. Daily summary of tagged, untagged, and recaptured chum salmon at the Kalskag site on the Kuskokwim River, 2002.

Kalskag										
Capture Gear							Tag Site/ Recapture Site		Total	Cumm. % Catch
Date	Fish Wheel				Gillnet					
	Tagged		Untagged				Aniak/	Kalskag/		
	RB[1/]	LB[2/]	RB[1/]	LB[2/]	Tagged	Un-tagged	Kalskag	Kalskag		
18-Jun	0	3	0	0	0	0	0	0	3	0
19-Jun	3	2	0	0	0	0	0	0	5	0
20-Jun	2	11	0	0	8	0	0	0	21	0
21-Jun	3	6	1	0	4	0	0	0	14	0
22-Jun	4	13	0	0	2	0	0	0	19	1
23-Jun	44	35	0	4	9	0	0	0	92	2
24-Jun	36	19	2	1	12	0	0	0	70	3
25-Jun	36	14	1	1	6	0	0	1	59	3
26-Jun	32	20	1	1	10	0	0	1	65	4
27-Jun	43	25	1	0	7	0	0	1	77	5
28-Jun	58	13	0	0	2	0	0	1	74	6
29-Jun	45	22	0	3	9	0	0	0	79	7
30-Jun	35	32	0	1	17	0	0	0	85	8
01-Jul	53	40	0	0	0	0	0	1	94	9
02-Jul	132	29	1	1	5	1	0	4	173	11
03-Jul	119	42	0	1	0	0	2	2	166	13
04-Jul	121	46	14	5	0	0	0	0	186	15
05-Jul	230	73	8	3	0	0	0	1	315	18
06-Jul	143	113	6	13	3	0	1	2	281	22
07-Jul	206	106	10	5	0	0	0	4	331	25
08-Jul	168	98	6	4	0	0	0	3	279	29
09-Jul	198	102	7	11	0	0	0	4	322	32
10-Jul	164	153	8	10	0	0	0	3	338	36
11-Jul	180	117	15	3	0	0	0	5	320	40
12-Jul	182	64	33	6	4	0	0	4	293	43
13-Jul	151	78	5	7	5	1	0	5	252	46
14-Jul	190	89	9	8	7	2	0	5	310	50
15-Jul	146	59	10	8	6	0	1	2	232	52
16-Jul	159	52	19	2	0	0	1	5	238	55
17-Jul	121	43	5	7	0	1	5	3	185	57
18-Jul	112	54	4	6	5	0	0	6	187	59
19-Jul	203	164	11	11	2	0	1	8	400	64
20-Jul	191	95	15	5	0	0	0	7	313	68
21-Jul	165	74	9	6	0	0	1	7	262	71
22-Jul	111	46	11	4	1	0	0	6	179	73
23-Jul	87	44	15	10	2	0	0	6	164	74
24-Jul	156	38	23	5	6	1	0	5	234	77
25-Jul	121	71	9	7	0	0	0	7	215	80
26-Jul	143	54	11	7	2	0	0	6	223	82
27-Jul	58	62	3	4	1	0	0	4	132	84
28-Jul	72	24	7	4	3	0	0	2	112	85
29-Jul	101	55	11	7	1	0	1	4	180	87
30-Jul	71	30	20	7	1	0	0	3	132	89
31-Jul	95	40	15	19	0	1	1	3	174	91

Appendix C1. (Continued)

Kalskag										
Capture Gear							Tag Site/ Recapture Site		Total	Cumm. % Catch
Date	Fish Wheel				Gillnet		Aniak/	Kalskag/		
	Tagged		Untagged		Tagged	Un-tagged	Kalskag	Kalskag		
	RB[1/]	LB[2/]	RB[1/]	LB[2/]						
01-Aug	53	26	7	4	1	3	0	4	98	92
02-Aug	15	14	1	3	0	1	0	2	36	92
03-Aug	23	10	4	4	1	0	1	0	43	93
04-Aug	21	13	2	0	2	1	0	3	42	93
05-Aug	27	9	11	0	2	0	0	3	52	94
06-Aug	26	44	4	2	1	0	0	4	81	95
07-Aug	21	19	10	1	3	2	0	2	58	95
08-Aug	22	23	2	4	3	1	0	3	58	96
09-Aug	14	13	2	4	1	0	1	1	36	96
10-Aug	8	8	5	1	2	0	0	1	25	97
11-Aug	17	10	0	1	0	0	0	0	28	97
12-Aug	7	2	3	2	0	0	0	1	15	97
13-Aug	8	4	1	1	0	0	0	2	16	97
14-Aug	4	7	1	1	0	0	1	0	14	97
15-Aug	4	3	0	1	0	0	0	0	8	98
16-Aug	5	3	1	1	0	0	0	0	10	98
17-Aug	3	8	4	1	1	4	0	1	22	98
18-Aug	8	3	1	1	0	1	0	1	15	98
19-Aug	8	5	1	1	0	1	0	1	17	98
20-Aug	6	3	5	2	0	0	0	0	16	98
21-Aug	6	4	3	5	0	0	0	1	19	99
22-Aug	5	16	4	2	1	0	0	0	28	99
23-Aug	0	0	0	2	1	0	0	0	3	99
24-Aug	4	6	2	7	0	0	0	0	19	99
25-Aug	2	6	0	2	0	0	0	1	11	99
26-Aug	1	3	0	2	0	0	0	0	6	99
27-Aug	0	1	1	0	0	0	0	0	2	100
28-Aug	2	1	3	3	0	0	0	0	9	100
29-Aug	1	0	0	0	0	0	0	0	1	100
30-Aug	2	0	1	0	0	0	0	0	3	100
31-Aug	1	1	2	2	0	0	0	0	6	100
01-Sep	1	0	1	0	0	0	0	0	2	100
02-Sep	3	0	0	0	0	0	0	0	3	100
03-Sep	0	0	1	1	0	0	1	0	3	100
04-Sep	1	3	0	0	0	0	0	0	4	100
05-Sep	1	0	0	0	0	0	0	0	1	100
06-Sep	0	1	0	1	0	0	0	1	3	100
07-Sep	0	1	0	2	0	0	0	0	3	100
08-Sep	0	2	0	1	0	0	0	0	3	100
09-Sep	0	1	0	0	0	0	0	0	1	100
10-Sep	0	0	0	1	0	0	0	0	1	100
Total	**5,020**	**2,643**	**409**	**273**	**159**	**21**	**18**	**163**	**8,706**	

[1/] Right Bank Fish Wheel when facing downstream
[2/] Left Bank Fish Wheel

Appendix C2. Daily summary of tagged, untagged, and recaptured chum salmon at the Aniak on the Kuskokwim River, 2002.

Aniak										
Capture Gear							Tag Site/ Recapture Site		Total	Cumm. % Catch
Date	Fish Wheel				Gillnet		Kalskag/	Aniak/		
	Tagged		Un-tagged		Tagged	Un-tagged	Aniak	Aniak		
	RB[1/]	LB[2/]	RB[1/]	LB[2/]						
14-Jun	3	0	0	0	0	0	0	0	3	0
15-Jun	21	0	3	0	0	0	0	0	24	0
16-Jun	58	0	7	0	0	0	0	0	65	0
17-Jun	50	0	15	0	0	0	0	1	66	1
18-Jun	33	28	3	0	0	0	0	1	65	1
19-Jun	55	1	2	0	7	0	0	1	66	1
20-Jun	47	0	0	0	7	0	0	0	54	2
21-Jun	53	0	3	0	20	0	0	0	76	2
22-Jun	88	0	8	0	6	0	0	1	103	3
23-Jun	130	2	9	0	0	0	0	0	141	3
24-Jun	151	11	7	4	5	0	5	1	184	4
25-Jun	122	35	6	7	5	0	1	1	177	5
26-Jun	99	59	9	5	6	0	2	1	181	6
27-Jun	174	114	13	19	0	0	0	1	321	8
28-Jun	176	109	24	23	1	3	2	2	340	10
29-Jun	156	129	24	31	0	0	3	2	345	11
30-Jun	148	180	21	24	0	0	1	3	377	13
01-Jul	199	185	60	43	0	0	1	4	492	16
02-Jul	129	180	81	175	0	0	4	2	571	19
03-Jul	175	159	47	127	0	0	2	2	512	22
04-Jul	178	220	153	110	0	0	7	5	673	25
05-Jul	197	179	58	130	0	0	3	2	569	28
06-Jul	289	140	119	124	0	0	5	4	681	32
07-Jul	230	159	170	174	0	0	5	0	738	35
08-Jul	331	161	130	155	0	0	8	3	788	39
09-Jul	184	135	73	182	0	0	7	2	583	42
10-Jul	208	199	78	244	0	0	3	1	733	46
11-Jul	161	180	71	289	0	0	18	3	722	50
12-Jul	175	233	67	296	0	0	14	3	788	54
13-Jul	101	193	38	140	0	0	8	3	483	57
14-Jul	63	99	167	294	0	0	7	1	631	60
15-Jul	32	34	170	241	0	0	10	1	488	63
16-Jul	128	341	25	90	0	0	10	4	598	66
17-Jul	139	157	34	51	0	0	13	4	398	68
18-Jul	163	121	26	98	0	0	10	4	422	70
19-Jul	185	98	37	29	0	0	7	0	356	72
20-Jul	107	183	93	52	0	0	9	1	445	74
21-Jul	122	177	109	243	0	0	10	3	664	77
22-Jul	108	83	36	46	0	0	11	4	288	79
23-Jul	127	98	48	54	0	0	8	6	341	81
24-Jul	106	42	45	9	0	0	7	3	212	82
25-Jul	124	64	23	33	0	0	6	2	252	83
26-Jul	114	65	45	12	1	0	7	3	247	84
27-Jul	88	108	68	78	0	0	4	2	348	86
28-Jul	69	169	36	115	0	0	5	5	399	88
29-Jul	74	152	10	66	0	0	5	8	315	90
30-Jul	79	95	7	9	0	0	3	2	195	91
31-Jul	53	139	8	36	3	0	5	3	247	92
01-Aug	42	169	2	22	8	0	3	6	252	93
02-Aug	28	151	3	24	5	0	3	2	216	95
03-Aug	22	76	1	22	2	0	2	3	128	95
04-Aug	27	64	5	7	0	0	3	3	109	96

Appendix C2. (Continued)

Aniak										
Capture Gear							Tag Site/ Recapture Site		Total	Cumm. % Catch
Date	Fish Wheel				Gillnet		Kalskag/	Aniak/		
	Tagged		Untagged		Tagged	Un-tagged				
	RB[1/]	LB[2/]	RB[1/]	LB[2/]			Aniak	Aniak		
05-Aug	25	69	6	13	4	2	5	1	125	96
06-Aug	20	48	2	17	1	2	4	0	94	97
07-Aug	38	57	4	7	2	1	6	1	116	98
08-Aug	25	38	3	7	3	0	1	1	78	98
09-Aug	16	12	4	4	2	0	1	0	39	98
10-Aug	5	13	1	5	1	0	1	0	26	98
11-Aug	8	10	2	2	1	0	0	0	23	98
12-Aug	6	10	0	1	2	0	1	1	21	98
13-Aug	4	19	1	4	0	0	1	1	30	99
14-Aug	5	17	0	0	1	0	0	0	23	99
15-Aug	0	9	0	2	0	0	2	0	13	99
16-Aug	0	24	0	3	0	0	2	1	30	99
17-Aug	1	15	1	6	1	0	1	1	26	99
18-Aug	5	14	1	5	2	2	1	1	31	99
19-Aug	3	10	0	1	0	0	4	0	18	99
20-Aug	2	9	0	2	4	0	1	1	19	99
21-Aug	10	3	0	0	3	0	0	0	16	100
22-Aug	6	9	0	2	3	0	1	0	21	100
23-Aug	5	2	0	1	2	0	0	0	10	100
24-Aug	2	1	1	1	0	1	0	0	6	100
25-Aug	2	1	0	1	0	0	0	0	4	100
26-Aug	0	2	0	2	0	0	0	0	4	100
27-Aug	1	0	0	0	1	1	0	0	3	100
28-Aug	0	1	0	0	1	0	0	0	2	100
29-Aug	1	0	1	0	0	0	0	0	2	100
30-Aug	1	1	0	3	0	0	0	0	5	100
31-Aug	2	1	1	3	0	0	0	1	8	100
01-Sep	0	0	0	0	1	0	0	1	2	100
02-Sep	0	0	0	1	0	0	0	0	1	100
03-Sep	0	0	0	4	0	0	0	0	4	100
04-Sep	0	2	0	0	0	0	0	0	2	100
05-Sep	1	1	0	1	0	0	0	0	3	100
06-Sep	0	0	0	0	0	0	0	0	0	100
07-Sep	0	1	0	0	0	0	0	0	1	100
08-Sep	0	0	0	0	0	0	0	0	0	100
09-Sep	1	0	0	1	0	0	0	0	2	100
10-Sep	1	0	0	0	0	0	0	0	1	100
11-Sep	1	1	1	0	0	0	0	0	3	100
Total	**6,318**	**6,076**	**2,326**	**4,032**	**111**	**12**	**279**	**130**	**19,284**	

[1/] Right Bank Fish Wheel when facing downstream
[2/] Left Bank Fish Wheel

Appendix D. Number of recovered tags from chum salmon by subsistence, commercial, and sport fishers at locations downstream and upstream from the Kalskag and Aniak tag sites on the Kuskokwim River, 2002.

Community	Fishery Type									
	Subsistence			Commercial			Sports			Grand Total
	Tag Site			Tag Site			Tag Site			
Downstream	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Johnson River	0	1	1	0	1	1	0	0	0	**2**
Napakiak	4	11	15	0	0	0	0	0	0	**15**
Oscarville	1	1	2	0	0	0	0	0	0	**2**
Bethel	10	11	21	2	5	7	0	1	1	**29**
Gweek	1	1	2	0	0	0	0	0	0	**2**
Kwethluk	18	27	45	1	0	1	0	0	0	**46**
Akiak	27	41	68	5	3	8	0	0	0	**76**
Akiachak	20	27	47	3	0	3	0	0	0	**50**
Tuluksak	7	20	27	0	0	0	0	0	0	**27**
Total	**88**	**140**	**228**	**11**	**9**	**20**	**0**	**1**	**1**	**249**

Near Tag Site	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Kalskag	34	37	71	0	0	0	0	0	0	**71**
Aniak	4	15	19	0	0	0	0	0	0	**19**
Total	**38**	**52**	**90**	**0**	**0**	**0**	**0**	**0**	**0**	**90**

Upstream	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Aniak	35	67	102	0	0	0	19	21	40	**142**
Chuathbaluk	14	15	29	0	0	0	0	0	0	**29**
Napaimiut	3	6	9	0	0	0	0	0	0	**9**
Holokuk River	0	1	1	0	0	0	0	0	0	**1**
Crooked Creek	12	16	28	0	0	0	0	0	0	**28**
Oskawalik River	1	0	1	0	0	0	0	0	0	**1**
Georgetown	0	1	1	0	0	0	2	1	3	**4**

Appendix D (Continued)

Community	Fishery Type									
	Subsistence			Commercial			Sports			Grand Total
	Tag Site			**Tag Site**			**Tag Site**			
Upstream	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Red Devil	9	19	28	0	0	0	0	0	0	**28**
Sleetmute	15	14	29	0	0	0	1	0	1	**30**
Holitna	4	1	5	0	0	0	0	1	1	**6**
Stony River	11	22	33	0	0	0	1	0	1	**34**
McGrath	0	2	2	0	0	0	0	1	1	**3**
Takotna River	0	0	0	1	0	1	0	0	0	**1**
Nikolai	0	1	1	0	0	0	0	0	0	1
Total	104	165	269	1	0	1	23	24	47	317

Unknown	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Total	**10**	**12**	**22**	**0**	**0**	**0**	**0**	**0**	**0**	**22**

Combined	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Total	**240**	**369**	**609**	**12**	**9**	**21**	**23**	**24**	**48**	**678**

Appendix E:

Appendix E1. Daily summary of tagged, untagged, and recaptured coho salmon at the Kalskag site on the Kuskokwim River, 2002.

Kalskag										
Capture Gear							Tag Site/ Recapture Site		Total	Cumm. % Catch
Date	Fish Wheel				Gillnet					
	Tagged		Untagged		Tagged	Untagged	Aniak/ Kalskag	Kalskag/ Kalskag		
	RB[1/]	LB[2/]	RB[1/]	LB[2/]						
28-Jun	0	1	0	0	0	0	0	0	1	0
08-Jul	1	0	0	0	0	0	0	0	1	0
09-Jul	0	0	0	0	0	0	0	0	0	0
10-Jul	1	1	0	0	0	0	0	0	2	0
11-Jul	1	0	0	0	0	0	0	0	1	0
12-Jul	0	0	0	0	0	0	0	0	0	0
13-Jul	0	0	0	0	0	0	0	0	0	0
14-Jul	3	0	0	0	0	0	0	0	3	0
15-Jul	0	0	0	0	0	0	0	0	0	0
16-Jul	0	0	0	0	0	0	0	0	0	0
17-Jul	0	0	0	0	0	0	0	0	0	0
18-Jul	1	0	0	0	0	0	0	0	1	0
19-Jul	6	0	0	0	0	0	0	0	6	0
20-Jul	3	3	0	0	0	0	0	0	6	1
21-Jul	5	4	0	0	0	0	0	0	9	1
22-Jul	4	1	0	0	0	0	0	0	5	1
23-Jul	13	2	0	0	0	0	0	1	16	2
24-Jul	11	3	1	0	0	0	0	1	16	2
25-Jul	14	4	0	1	0	0	0	0	19	3
26-Jul	12	3	0	0	0	0	0	0	15	3
27-Jul	6	8	0	0	0	0	0	0	14	4
28-Jul	20	2	1	0	0	0	0	0	23	4
29-Jul	15	5	0	0	0	0	0	1	21	5
30-Jul	13	1	4	0	4	0	0	2	24	6
31-Jul	33	4	4	2	7	0	0	0	50	8
01-Aug	23	6	0	0	9	0	0	1	39	9
02-Aug	16	2	0	0	18	1	0	1	38	10
03-Aug	16	7	0	0	21	0	0	1	45	11
04-Aug	10	4	0	0	21	11	0	0	46	13
05-Aug	22	4	2	2	27	0	0	0	57	15
06-Aug	55	30	1	2	11	1	1	1	102	18
07-Aug	43	8	0	1	27	2	0	1	82	21
08-Aug	53	26	2	3	12	2	0	1	99	24
09-Aug	41	21	3	1	9	0	0	3	78	27
10-Aug	18	10	0	0	16	1	0	1	46	28
11-Aug	22	8	0	1	15	1	0	0	47	30
12-Aug	25	4	0	0	15	2	0	0	46	31
13-Aug	61	10	1	0	28	3	1	0	104	34
14-Aug	33	9	2	0	22	2	0	1	69	37
15-Aug	29	10	3	0	18	0	0	1	61	39
16-Aug	31	5	0	0	25	0	0	0	61	41
17-Aug	19	5	2	0	36	0	0	0	62	43
18-Aug	23	7	1	0	24	0	1	0	56	45
19-Aug	20	6	5	0	14	4	0	0	49	46
20-Aug	25	15	6	3	25	2	0	0	76	49
21-Aug	44	19	3	2	2	1	0	2	73	51
22-Aug	88	32	2	0	9	2	0	3	136	55
23-Aug	70	26	4	1	14	1	0	2	118	59
24-Aug	51	30	2	2	14	10	2	0	111	63
25-Aug	91	29	1	0	8	0	0	1	130	67
26-Aug	49	16	5	4	15	6	0	3	98	70
27-Aug	66	13	4	0	17	0	0	2	102	74
28-Aug	30	14	3	0	8	1	0	0	56	75
29-Aug	32	9	3	3	10	1	0	1	59	77

Appendix E1. (Continued)

Kalskag										
Capture Gear							Tag Site/ Recapture Site		Total	Cumm. % Catch
Date	Fish Wheel				Gillnet		Aniak/	Kalskag/		
	Tagged		Untagged							
	RB	LB	RB	LB	Tagged	Untagged	Kalskag	Kalskag		
30-Aug	36	19	3	1	12	2	0	0	73	80
31-Aug	36	15	0	2	28	1	1	0	83	82
01-Sep	31	13	2	3	4	3	1	2	59	84
02-Sep	50	31	3	2	8	0	1	3	98	88
03-Sep	28	15	4	1	24	3	0	1	76	90
04-Sep	21	18	4	0	14	1	0	0	58	92
05-Sep	32	17	1	2	9	4	1	2	68	94
06-Sep	27	5	1	1	12	0	0	0	46	96
07-Sep	11	7	3	3	8	1	1	0	34	97
08-Sep	19	10	0	0	11	1	1	0	42	98
09-Sep	17	9	0	0	2	0	0	0	28	99
10-Sep	8	9	2	0	1	0	0	0	20	100
11-Sep	8	3	0	0	0	0	0	0	11	100
Total	1,592	598	88	43	634	70	11	39	3,075	

[1/] Right Bank Fish Wheel when facing downstream
[2/] Left Bank Fish Wheel

Appendix E2. Daily summary of tagged, untagged, and recaptured coho salmon at the Aniak site on the Kuskokwim River, 2002.

Aniak										
Capture Gear							Tag Site/ Recapture Site		Total	Cumm. % Catch
Date	Fish Wheel				Gillnet					
	Tagged		Untagged		Tagged	Untagged	Kalskag/ Aniak	Aniak/ Aniak		
	RB[1/]	LB[2/]	RB[1/]	LB[2/]						
13-Jul	1	0	0	0	0	0	0	0	1	0
14-Jul	0	0	0	0	0	0	0	0	0	0
15-Jul	0	0	0	0	0	0	0	0	0	0
16-Jul	1	2	0	0	0	0	0	0	3	0
17-Jul	1	0	0	0	0	0	0	0	1	0
18-Jul	1	1	1	0	0	0	0	0	3	0
19-Jul	2	0	0	0	0	0	0	0	2	0
20-Jul	5	1	0	0	0	0	0	0	6	0
21-Jul	4	0	0	1	0	0	0	0	5	0
22-Jul	3	1	1	0	0	0	0	0	5	1
23-Jul	6	5	0	0	0	0	0	0	11	1
24-Jul	3	0	1	0	0	0	0	0	4	1
25-Jul	9	5	0	0	0	0	0	0	14	1
26-Jul	13	3	1	0	1	0	1	0	19	2
27-Jul	6	4	0	0	0	0	1	0	11	2
28-Jul	11	5	3	1	0	0	0	1	21	2
29-Jul	31	8	1	0	0	0	0	0	40	3
30-Jul	32	3	1	0	0	0	0	0	36	4
31-Jul	29	13	0	0	8	0	0	0	50	5
01-Aug	41	12	0	1	13	1	1	0	69	7
02-Aug	35	22	1	1	16	0	0	1	76	9
03-Aug	39	13	1	1	11	0	0	2	67	10
04-Aug	41	11	0	0	2	0	0	0	54	11
05-Aug	64	32	5	2	16	0	0	0	119	14
06-Aug	46	61	1	5	9	0	4	1	127	17
07-Aug	91	45	2	1	17	0	0	2	158	20
08-Aug	69	50	0	0	25	6	1	1	152	24
09-Aug	47	34	3	1	23	0	0	2	110	26
10-Aug	47	37	1	1	32	0	1	0	119	29
11-Aug	44	40	2	0	11	2	2	0	101	31
12-Aug	65	41	2	1	18	1	1	1	130	34
13-Aug	61	43	3	2	25	1	2	0	137	37
14-Aug	54	44	3	2	31	7	1	1	143	41
15-Aug	75	16	1	0	15	0	1	1	109	43
16-Aug	50	27	0	3	63	4	0	0	147	47
17-Aug	55	41	1	2	43	1	0	2	145	50
18-Aug	50	60	0	0	17	0	1	2	130	53
19-Aug	56	42	1	2	43	0	1	4	149	56
20-Aug	43	37	3	1	78	6	0	1	169	60
21-Aug	47	27	0	3	59	1	0	1	138	63
22-Aug	29	22	5	0	66	0	1	3	126	66
23-Aug	34	9	0	0	70	2	0	0	115	69
24-Aug	43	10	1	0	30	3	0	1	88	71
25-Aug	35	16	1	1	25	0	0	0	78	72
26-Aug	37	21	0	2	23	0	3	2	88	74
27-Aug	38	18	0	1	29	3	0	2	91	76
28-Aug	18	11	1	2	25	1	1	0	59	78
29-Aug	18	18	0	2	12	0	1	0	51	79
30-Aug	64	13	1	0	8	0	0	1	87	81
31-Aug	54	36	3	4	10	0	2	1	110	0

Appendix E2. (Continued)

Aniak										
Capture Gear							Tag Site/ Recapture Site		Total	Cumm. % Catch
Date	Fish Wheel				Gillnet					
	Tagged		Untagged				Kalskag/	Aniak/		
	RB[1/]	LB[2/]	RB[1/]	LB[2/]	Tagged	Untagged	Aniak	Aniak		
01-Sep	33	51	2	1	24	2	4	3	120	83
02-Sep	66	35	3	3	18	2	5	0	131	86
03-Sep	37	29	0	3	14	2	3	2	89	89
04-Sep	44	34	1	2	14	1	2	1	99	91
05-Sep	27	18	2	1	5	1	4	2	60	93
06-Sep	23	6	0	1	6	0	1	0	37	95
07-Sep	34	11	0	2	1	0	1	0	49	96
08-Sep	22	5	1	0	3	0	2	0	33	97
09-Sep	19	3	2	1	4	0	2	0	31	97
10-Sep	24	2	0	1	4	0	0	0	31	98
11-Sep	29	2	1	0	0	0	0	0	32	99
12-Sep	16	3	0	0	0	0	1	1	21	100
Total	**2,022**	**1,159**	**63**	**58**	**967**	**47**	**51**	**42**	**4,409**	

[1/] Right Bank Fish Wheel when facing downstream
[2/] Left Bank Fish Wheel

Appendix F. Number of recovered tags from coho salmon by subsistence, commercial, and sport fishers at locations downstream and upstream from the Kalskag and Aniak tag sites on the Kuskokwim River, 2002.

Community	Fishery Type									
	Subsistence			Commercial			Sports			*Grand Total*
	Tag Site			**Tag Site**			**Tag Site**			
Downstream	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Bethel	4	2	**6**	0	3	**3**	0	0	**0**	**9**
Kwethluk	5	2	**7**	1	1	**2**	0	0	**0**	**9**
Akiachak	3	3	**6**	0	1	**1**	0	0	**0**	**7**
Akiak	3	1	**4**	1	1	**2**	0	0	**0**	**6**
Oscarville	0	1	**1**	0	0	**0**	0	0	**0**	**1**
Tuluksak	6	6	**12**	1	0	**1**	0	0	**0**	**13**
Fowler Island	0	0	**0**	1	0	**1**	0	0	**0**	**1**
Johnson River	0	0	**0**	1	0	**1**	0	0	**0**	**1**
Total	**21**	**15**	**36**	**5**	**6**	**11**	**0**	**0**	**0**	**47**

Near Tag Site	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Aniak	2	1	**3**	0	0	0	0	0	0	**3**
Kalskag	13	5	**18**	0	0	0	0	0	0	**18**
Total	**15**	**6**	**21**	**0**	**0**	**0**	**0**	**0**	**0**	**21**

Upstream	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Aniak	**19**	**37**	**56**	**0**	**0**	**0**	**10**	**22**	**32**	**88**
Oskawalik River	**0**	**1**	**1**	**0**	**0**	**0**	**2**	**2**	**4**	**5**
Georgetown	**6**	**9**	**15**	**0**	**0**	**0**	**2**	**2**	**4**	**19**
Sleetmute	**2**	**6**	**8**	**0**	**0**	**0**	**1**	**2**	**3**	**11**
Holitna River	**0**	**1**	**1**	**0**	**0**	**0**	**4**	**1**	**5**	**6**
Stony River	**2**	**3**	**5**	**0**	**0**	**0**	**1**	**1**	**2**	**7**

Appendix F (Continued)

Community	Fishery Type									
	Subsistence			Commercial			Sports			Grand Total
	Tag Site			**Tag Site**			**Tag Site**			
Upstream	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Chuathbaluk	2	2	4	0	0	0	0	0	0	**4**
Crooked Creed	2	3	5	0	0	0	1	0	1	**6**
Red Devil	3	6	9	0	0	0	0	0	0	**9**
McGrath	5	2	7	0	0	0	0	0	0	**7**
Nikolai	2	1	3	0	0	0	0	0	0	**3**
South Fork	0	0	0	0	0	0	1	0	1	**1**
Napaimiut	3	0	3	0	0	0	1	0	1	**4**
Total	**46**	**71**	**117**	**0**	**0**	**0**	**23**	**30**	**53**	**170**

Unknown	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Total	**2**	**4**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**6**

Combined	Kalskag	Aniak	Total	Kalskag	Aniak	Total	Kalskag	Aniak	Total	
Total	**84**	**96**	**180**	**5**	**6**	**11**	**23**	**30**	**53**	**244**